INTERNATIONAL LIBRARY OF TECHNOLOGY

A SERIES OF TEXTBOOKS FOR PERSONS ENGAGED IN THE ENGINEERING PROFESSIONS AND TRADES OR FOR THOSE WHO DESIRE INFORMATION CONCERNING THEM. FULLY ILLUSTRATED AND CONTAINING NUMEROUS PRACTICAL EXAMPLES AND THEIR SOLUTIONS

COTTON
PICKERS
COTTON CARDS
DRAWING ROLLS
RAILWAY HEADS AND DRAWING FRAMES
COMBERS
FLY FRAMES

SCRANTON:
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76

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PREFACE.

The International Library of Technology is the outgrowth of a large and increasing demand that has arisen for the Reference Libraries of the International Correspondence Schools on the part of those who are not students of the Schools. As the volumes composing this Library are all printed from the same plates used in printing the Reference Libraries above mentioned, a few words are necessary regarding the scope and purpose of the instruction imparted to the students of—and the class of students taught by—these Schools, in order to afford a clear understanding of their salient and unique features.

The only requirement for admission to any of the courses offered by the International Correspondence Schools, is that the applicant shall be able to read the English language and to write it sufficiently well to make his written answers to the questions asked him intelligible. Each course is complete in itself, and no textbooks are required other than those prepared by the Schools for the particular course selected. The students themselves are from every class, trade, and profession and from every country; they are, almost without exception, busily engaged in some vocation, and can spare but little time for study, and that usually outside of their regular working hours. The information desired is such as can be immediately applied in practice, so that the student may be enabled to exchange his present vocation for a more congenial one, or to rise to a higher level in the one he now pursues. Furthermore, he wishes to obtain a good working knowledge of the subjects treated in the shortest time and in the most direct manner possible.

In meeting these requirements, we have produced a set of books that in many respects, and particularly in the general plan followed, are absolutely unique. In the majority of subjects treated the knowledge of mathematics required is limited to the simplest principles of arithmetic and mensuration, and in no case is any greater knowledge of mathematics needed than the simplest elementary principles of algebra, geometry, and trigonometry, with a thorough, practical acquaintance with the use of the logarithmic table. To effect this result, derivations of rules and formulas are omitted, but thorough and complete instructions are given regarding how, when, and under what circumstances any particular rule, formula, or process should be applied; and whenever possible one or more examples, such as would be likely to arise in actual practice—together with their solutions—are given to illustrate and explain its application.

In preparing these textbooks, it has been our constant endeavor to view the matter from the student's standpoint, and to try and anticipate everything that would cause him trouble. The utmost pains have been taken to avoid and correct any and all ambiguous expressions—both those due to faulty rhetoric and those due to insufficiency of statement or explanation. As the best way to make a statement, explanation, or description clear is to give a picture or a diagram in connection with it, illustrations have been used almost without limit. The illustrations have in all cases been adapted to the requirements of the text, and projections and sections or outline, partially shaded, or full-shaded perspectives have been used, according to which will best produce the desired results. Half-tones have been used rather sparingly, except in those cases where the general effect is desired rather than the actual details.

It is obvious that books prepared along the lines mentioned must not only be clear and concise beyond anything heretofore attempted, but they must also possess unequaled value for reference purposes. They not only give the maximum of information in a minimum space, but this information is so ingeniously arranged and correlated, and the

indexes are so full and complete, that it can at once be made available to the reader. The numerous examples and explanatory remarks, together with the absence of long demonstrations and abstruse mathematical calculations, are of great assistance in helping one to select the proper formula, method, or process and in teaching him how and when it should be used.

Six of the volumes comprising this library are devoted to the subject of textile manufacturing. This volume, the first of the series, considers the cotton fiber and the processes through which cotton fibers have to pass before they can be spun into yarn. After describing the growth, characteristics, and the various classes of cotton, together with the action of the cotton gin, bale breakers, and pickers, consideration is given to the judging and mixing of cotton. Next, the important subject of cotton cards is taken up; a detailed description is given of card clothing and the action of the various parts of a cotton card. Several types of cotton cards are described, also the grinding and setting of these machines. Drawing rolls, which play such important parts in all these processes, are considered in detail, as regards both construction and setting. Then come drawing frames with their various stop-motions, combers, and finally fly frames. Of the latter, English as well as American types are shown and detailed information presented as regards calculations for producing the required hanks and twists.

The method of numbering the pages, cuts, articles, etc. is such that each subject or part, when the subject is divided into two or more parts, is complete in itself; hence, in order to make the index intelligible, it was necessary to give each subject or part a number. This number is placed at the top of each page, on the headline, opposite the page number; and to distinguish it from the page number it is preceded by the printer's section mark (§). Consequently, a reference such as § 16, page 26, will be readily found by looking along the inside edges of the headlines until § 16 is found, and then through § 16 until page 26 is found.

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CONTENTS

COTTON

COTTON CULTIVATION

INTRODUCTION

1. Principal Species.—Cotton is a vegetable fiber—the fruit of a plant belonging to the order of the Malvaceæ, to which belong the mallow, the hollyhock, and the okra. The cotton plant belongs to the genus **Gossypium**, and the number of species from a botanical point of view is variously stated as from four to eighty-eight, according to different botanists. The principal species of the cotton plant cultivated for commercial purposes are: *Gossypium herbaceum*, *Gossypium arboreum*, *Gossypium hirsutum*, and *Gossypium Barbadense*.

The species known as **Gossypium herbaceum** grows from 2 to 6 feet high and is found native or exotic in Northern Africa and in Asia; it is also largely cultivated in the United States of America.

The **Gossypium arboreum** grows to the height of 15 or 20 feet, whence it derives the name of tree cotton. The seeds are covered with a short green fiber. While the plant is found in Asia, it is most largely cultivated in Central and South America.

The **Gossypium hirsutum** is a shrubby plant, its maximum height being about 6 feet. The young pods are hairy; the seeds numerous, free, and covered with firmly adhering green down under the long white wool.

The **Gossypium Barbadense** attains a height of from 5 to 10 feet. The seeds of this plant are black and smooth and the fiber the longest known to commerce. The name is

derived from the fact that the plant is a native of the Barbados, or has been cultivated there for a long time. The sea-island cotton plant of the United States belongs to this species.

Cotton fiber is known to commerce under the simple name of *cotton* in English-speaking countries, although by some people it is spoken of as *cotton wool*. Its German name is *baum-wolle;* in French, its name is *coton;* in Spanish, it is called *algodon*.

2. Growth and Development.—In cultivating cotton in the United States, the time of planting the seed varies according to the latitude of the district in question, but occurs in April in the majority of districts. In some of the favored districts of Mississippi, Louisiana, and Texas, where the season is abnormally long, the seed is planted in the latter part of March. In the heart of the cotton belt, April 1 is accepted as a suitable date; in North and South Carolina and Tennessee it is considered unwise to plant before April 15; while in the extreme northern edge of the belt, as in Virginia, planting is deferred to the last days of April or early in May.

Germination occurs rapidly after the sowing of the seed, the first appearance of the plant above the ground being from 4 to 14 days after sowing. From the germination period until the middle of the summer the stalk and foliage of the plant are developed until the plant attains its maximum size; during this period hot, humid weather with frequent showers is favorable. From the middle of summer and onwards the bearing season of the plant occurs, when more heat and less moisture are desirable.

Usually about 40 days after the plant shows above the ground there appears the first **square**, or bud. From the formation of this bud 24 to 30 days elapse before the appearance of the flower. The flower on the first day of the opening of the bud is yellowish white and has five petals. One peculiarity of the cotton plant is in the change of color of the flower. This, which on the first day is of a shade varying from a dull white to a yellow, is found on the second day to be of a distinctly pink or reddish hue; the flower drops off on the succeeding, or third, day.

After the petals fall, there remains the small boll enveloped in the calyx; this develops until it becomes about the shape and size of an egg, and finally bursts from 50 to 60 days after the appearance of the flower.

When the boll bursts, it exposes from three to five cells divided by membranous walls; each cell contains seeds,

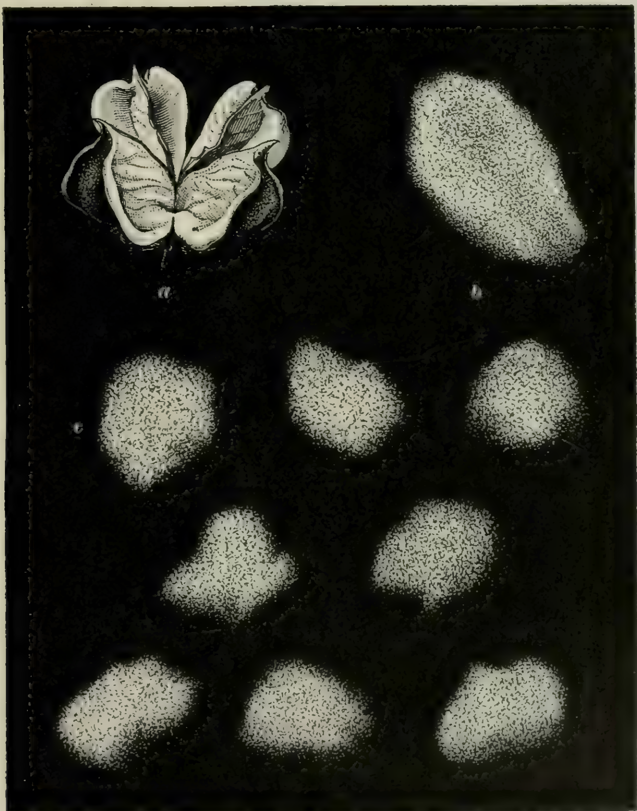


Fig. 1

which are attached by filaments to the membrane of the boll. The filaments ultimately disappear, leaving the seed loose in the cavity and covered with cotton. Each seed is entirely enveloped by the cotton fibers attached to it just as the

human hair is attached to the head. The seeds vary in number from thirty-two to thirty-six in each pod, or boll. The view at *a*, Fig. 1, shows an empty pod, or capsule; *b* is the seed cotton out of one cavity of the pod just as it appears after it has been removed by the fingers of the cotton picker; *c* shows the individual seeds and fibers of which the mass *b* is composed. The next view, Fig. 2, is a reproduction of sections of these seeds with the fibers radiating in all directions, each attached at one end to the seed. Botanists differ as to the exact cause of the bursting of the boll, but it is probably due to the increased space occupied by the fiber as it ripens and dries and the contraction and splitting of the pod from the same cause.

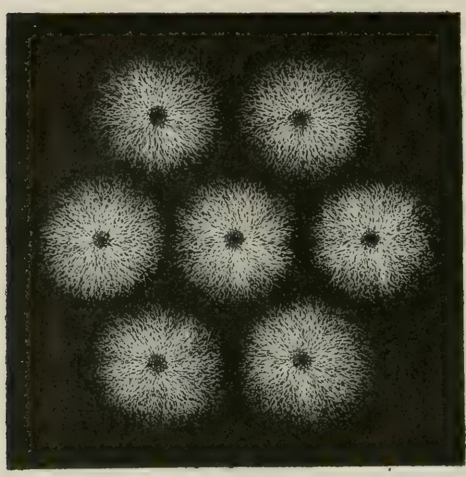


FIG. 2

3. The operations of cotton culture on land that has been previously cultivated, and on well-managed farms, may be summarized as follows, varying according to the latitude of the cotton field: Breaking up, burying vegetation, broadcast manuring, and harrowing, December and January; bedding up, February; fertilizing, March; sowing seeds, April; chopping out to a stand and throwing soil up to the root, May; (considerably more seeds are sown than plants required; the excess of plants are chopped out with hoes); cultivating by plow and hoe, or cultivator, latter part of May or in June; period of rest, part of July and part of August; picking, August, September, October, November, and if the season is an open one, December and even January.

STRUCTURE OF THE COTTON FIBER

4. The cotton fiber, which to the naked eye appears to be a fine, smooth, and solid filament, exhibits a somewhat complicated structure when examined under a microscope. A microscopic view of cotton fibers is shown in Fig. 3. Each fiber appears to be a collapsed tube with corded edges, twisted many times throughout its length and having the appearance of an elongated corkscrew. This semi-spiral construction assists in the formation of a strong thread from such a comparatively weak fiber as cotton. In the formation of a thread, the convolutions interlock with one another and help to resist any tension put on the yarn. These convolutions are less and less frequent as the fiber is less matured, and are almost altogether absent in the immature fiber, which has merely the appearance of a flattened ribbon when examined under a microscope. The immature fiber is transparent and has a glossy appearance, so that when it exists in any quantity in a bale of cotton it can readily be detected with the naked eye. It has the feature of not taking dye so readily as ripened cotton.

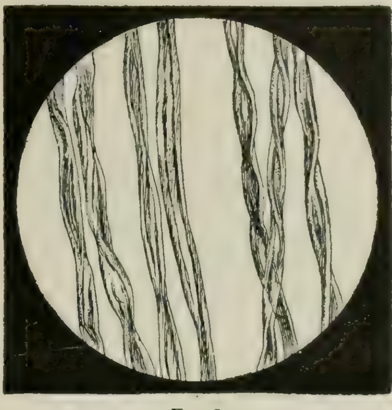


FIG. 3

If examined under a more powerful microscope, the cotton fiber is found to consist of four distinct membranes, or layers of matter. Ignoring the removable foreign matter contained in raw cotton, such as sand and other mineral substances, leaf, pieces of boll, or stalk, and considering the fiber as being entirely cleared from this, it is found to be composed of cellulose, permeated by a small amount of mineral matter, and that each fiber is surrounded by soluble substances present to the extent of from 1 to 2 per cent. The small

amount of mineral matter may be liberated by burning the fiber, the inorganic matter remaining as an ash retaining more or less the formation of the fiber and being about 1 per cent. of the original weight.

Cellulose is the largest constituent of the cotton fiber; in fact, it is the chief constituent of almost everything of vegetable origin, but is found with its most characteristic features in such commercial fibers as cotton, ramie, flax, and so on. It is a carbohydrate, so called because it is composed of carbon, hydrogen, and oxygen, the hydrogen and oxygen being present in the same proportion as in water. It is this cellulose that absorbs and retains moisture, the cellulose in the cotton fiber, when in an air-dry condition, containing about 7½ per cent.

The soluble substances present in the cotton fiber, principally located on the outside, are waxy or oily substances permeated with other material and amounting in the aggregate to from 1½ to 2 per cent. of the weight of raw cotton. The nature of these materials is, as yet, more or less obscure; the portion that is removable by scouring with a weak solution of soda ash is commonly spoken of as *cotton wax*, while others removable by prolonged boiling in distilled water are given the name of *water extract*.

5. The amount of removable foreign matter in cotton varies greatly with the variety, and even in different growths of the same variety. It is present to the extent of from 1 per cent. in carefully cultivated sea-island to 6 per cent. or more in coarse, negligently cultivated East Indian cotton. Assuming 2 per cent. as a fair average, the following data represent the constituent parts of what is commercially known as raw cotton: Cellulose, 87 per cent.; waxy, or other easily soluble substances, 2 per cent.; ash, 1 per cent. (giving 90 per cent. of fiber if absolutely dry); removable foreign matter, 2 per cent.; moisture, 8 per cent. Of course no two analyses give the same result and these figures only represent what would be found in an average of American-grown cotton in an air-dry condition.

6. The property of containing and retaining moisture, even when in an air-dry condition, or *hygroscopicity*, is common to most of the commercial textile fibers, although cotton possesses this property to a smaller extent than most other fibrous materials. There is a quantity of water always present in cotton that cannot be driven out by a moderate heat, and which, even after it has been expelled by excessive heat, is replaced by moisture from the atmosphere when the superheated cotton is allowed to stand in the open air. When in an air-dry state, under ordinary atmospheric conditions, cotton contains about 8 per cent. of moisture.

The expression *air dry* is used to describe the condition of cotton after it has been exposed to the atmosphere for such a length of time and under such conditions as will cause it to lose all excessive moisture or regain deficient moisture, so as to be in a normal condition. The expression *absolutely dry cotton* means cotton that has been heated to such a high temperature and under such conditions that all the moisture has been expelled and the sample being tested will cease to lose weight.

Moisture is necessary to the satisfactory manipulation of the fiber in spinning, and if for any reason a portion of this natural moisture is driven out, the spinning of the yarn is rendered more difficult until it is replaced. Frequently, from 1 to $1\frac{1}{2}$ per cent. of excessive or artificial moisture is found in cotton beyond the amount named. The amount of moisture in raw cotton depends largely on the treatment of cotton after picking and before baling, on the age of the cotton, and where it has been stored. The largest amount of natural moisture in cotton is found immediately after it has been picked from the cotton plant, especially in the case of cotton picked early in the season. In some districts, especially in the sea islands, it is customary to spread the newly picked cotton in the sun, to ripen and dry it, before ginning; but in the main cotton belt no such care is taken, the result being that the cotton is ginned while moist, tending to *gin damage;* but the planter ignores this in his anxiety to have it baled with as little loss of weight as possible.

The determination of the amount of moisture present is commonly spoken of as *conditioning*. The accurate meaning of this expression is the testing of raw stock, yarn, or fabrics as to what should be their true weight if the normal regain of moisture were added to their absolutely dry weight. From this expression, the name *conditioning houses* has been derived to indicate those establishments, very common in Europe, where fibrous substances are tested as to their hygroscopic conditions. At all these, the standard of moisture in cotton is what is known as an $8\frac{1}{2}$*-per-cent. regain*. This does not mean that every 100 pounds, or other units of weight of cotton, when in an air-dry condition contains $8\frac{1}{2}$ units of water; the meaning of the term is that if a sample of cotton has been subjected to sufficient heat to render it absolutely dry, each 100 parts by weight when exposed to ordinary atmospheric conditions will regain $8\frac{1}{2}$ parts. Thus, in an absolutely dry condition, such a sample of cotton would contain 7.834 per cent. of water, which is the relation of $8\frac{1}{2}$ to $108\frac{1}{2}$.

7. Measurements of the Cotton Fiber.—Cotton fibers even from the same seed vary considerably in length and in diameter, and only approximate measurements can be given. The diameter of a cotton fiber varies from .0004 to .001 inch, and the length of the fiber from $\frac{1}{2}$ inch to $2\frac{1}{4}$ inches. Doctor Bowman is the authority for stating that there are 140,000,000 fibers in a pound. The general average measurements for cottons of the United States are given in the United States Government Tenth Census Reports as follows: Length, 1.10 inches (27.89 millimeters); diameter, .00091 inch (.023 millimeter); strength, 125.6 grains (8.14 grams).

The strength of individual cotton fibers varies from 75 to 300 grains, according to the kind of cotton, the distance between the points of suspension in making the test, and the portion of the fiber selected for the test. Usually the long-stapled, fine cottons break with the least strain, and the short coarse cottons stand the greatest strain. The ordinary American cottons have a breaking strain of from 120 to 140 grains.

8. Testing Yarns and Fabrics Containing Cotton. It is sometimes necessary to determine whether or not a fabric or a yarn is made of cotton, and while the experienced manufacturer is usually able to detect this by the appearance of the fabric, there are several tests that can be applied. In the first place, a microscope is useful, as the appearance of the cotton fiber when highly magnified is different from that of silk, linen, or wool, the wool fiber being covered with overlapping scales, silk being smooth like a glass rod, and linen showing the vascular fiber bundles that make up the complete fiber. In addition to the microscopical test, another may be made by burning a small portion of the yarn or fabric. Cotton will be found to burn with a flash, leaving a very light ash, while animal fibers, such as silk and wool, burn more slowly, emitting an offensive odor and leaving a curled bead, or globule, of carbonized matter. Chemical tests may also be made by which the nature of the fiber may be determined without any doubt.

COTTONS OF THE WORLD

9. Quantity and Quality Produced.—While the cotton crop of the United States is the most important and most useful in the world—being of such importance, in fact, that the price of American cotton practically controls the price of other cottons—there are numerous cotton fields in various parts of the world where extensive crops are raised and the product used for purposes for which American cotton cannot be utilized. The most important cotton-growing countries, other than the United States, are India, Egypt, China, and Brazil. Fig. 4 shows the proportion of cotton raised in several countries to the world's crop in 1900–1901.

Sea-island cotton of the United States represents the highest quality, and is spun into the finest yarn, being used very largely for thread, laces, and fine cambrics. Next in fineness of quality and length of staple is the brown Egyptian cotton, so called because of its brownish tinge, which is a distinctive feature of this fiber; this is very largely used

for fine cotton yarns and goods of all varieties. Among other long-staple cottons that are not important commercially are the Tahiti sea-island, the Peruvian, the white Egyptian, and Egyptian Gallini cottons. The next grade of cotton of any importance is known as Brazilian; it has a staple rather longer than the average American cotton, but is somewhat rough in appearance and touch. The American cottons form the next class, as regards quality, varying from the fine Mississippi cottons, Peelers, and benders, to the short, clean uplands cotton.

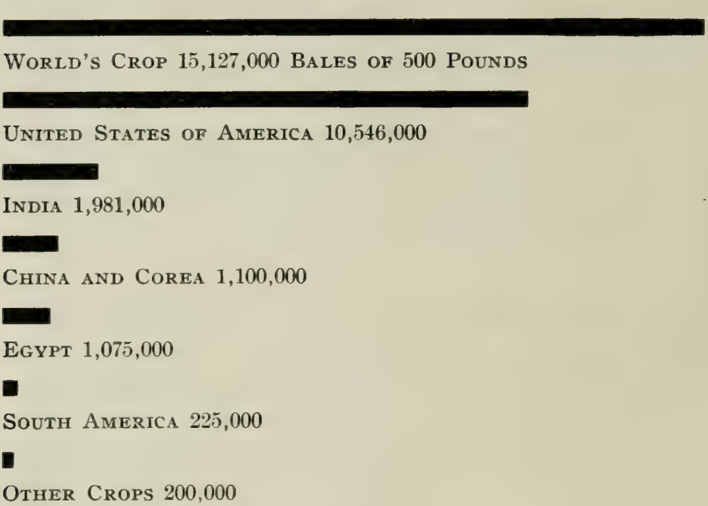


FIG. 4

Next to the United States, China produces one of the largest crops of cotton, which is almost all consumed in that country. It is a beautiful white cotton, somewhat harsh to the touch, but, unfortunately for its commercial importance, is comparatively short-staple, being about the length of the shortest American uplands cotton. The East India crop is also large, but is regarded as being both the dirtiest and the shortest-staple cotton produced.

10. Productive Regions.—Owing to the long seasons of considerable heat required in order to bring cotton to

maturity, this fiber can only be profitably cultivated in certain regions bordering north and south of the equator. This is usually described as being the regions bounded by the lines of latitude 45° north and 35° south of the equator, but no such arbitrary divisions can be made, as the isothermal lines must be taken into account. For instance, a line

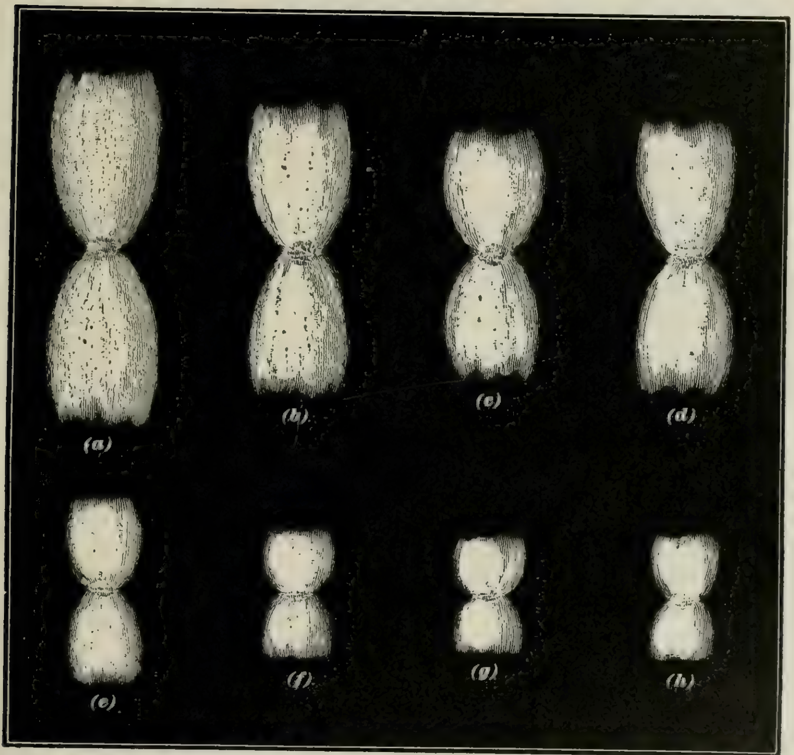


FIG. 5

drawn along 45° north latitude includes such districts as New England and portions of Canada, where it is impossible to grow cotton under natural conditions, while if the lines were drawn about 38° north latitude, which is the northern limit of cotton-growing districts in the United States, it would exclude portions of Turkestan, Southern Italy, Greece, and other

districts where it is possible to cultivate the cotton plant with success. Thus, an isotherm must be followed along the lines of equal temperature in the northern hemisphere, and another isothermal line in the southern hemisphere. This practically embraces in North America all the southern portion of the United States, including all of Georgia, South Carolina, Alabama, Mississippi, Texas, Louisiana, and Arkansas, and parts of Virginia, North Carolina, Tennessee, Indian Territory, California, and Florida; Mexico and Central America; and in South America, Peru, the Argentine Republic, Brazil, Venezuela, and Guiana. In Europe, the islands of Malta, Sicily, southern portions of Spain and Italy, and parts of Greece and Turkey are included, while the Asiatic countries are Arabia, Persia, Turkestan, India, China, Japan, and some of the islands in the Malay Archipelago. In Africa, a very large region is suited to the cultivation of cotton, but at present it is cultivated only in Egypt, in some of the countries on the western coast, and to a small extent in South Africa. In Australasia, it can be cultivated in Queensland and the Fiji Islands.

Fig. 5 shows the relative length of staples of the following leading growths: (*a*) American sea-island, (*b*) Peruvian, (*c*) Brazilian, (*d*) brown Egyptian, (*e*) American, (*f*) Indian, (*g*) Chinese, (*h*) Japanese.

Tables I, II, III, and IV show the relative importance, according to the quality, of cottons raised in various countries.

COTTON USED IN AMERICA

SEA-ISLAND COTTON

11. Sea-island cotton is the name used commercially to indicate the United States sea-island cotton. This is grown on Edisto, St. Helena, Port Royal, James, and John islands off the coast of South Carolina, St. Simon and Cumberland islands off the coast of Georgia, and others. It is recognized as being the best cotton that is grown in any

part of the world. Very careful attention is given to its cultivation and ginning, quality being considered before quantity, and thus sea-island cotton has a long, fine, strong and silky fiber with comparatively regular convolutions, of a diameter from .0004 to .0006 inch, ranging in length from $1\frac{3}{8}$ to $2\frac{1}{4}$ inches. The sea-island cotton crop is about 93,000 bales per annum; Charleston, South Carolina, is the leading market for it.

Sea-island cotton is largely used for thread and lace-making purposes, and is regularly spun into from 150s to 400s yarn, and occasionally, even for commercial purposes, as high as 600s. It is said that 2,150s yarn was spun from sea-island cotton at the exhibition of London in 1851. Where great strength is required for heavy goods, sea-island cotton is sometimes used, even for coarse yarns; as, for example, the linings of bicycle tires, sail cloth, and so on.

The variety of so-called Florida sea-island cotton is grown on the mainland of Florida from sea-island seed; this is somewhat inferior to the sea-island proper, but is a very useful cotton for making yarns of a little better quality than those made from Egyptian cotton. It has a white, glossy, strong fiber, a little coarser than the strictly sea-island, and is not quite so carefully cultivated. It is suitable for yarns from 150s to 200s.

AMERICAN COTTON

12. While the sea-island cottons just described are American, this name is seldom applied to them, but is used to indicate the typical cotton of the world, which is grown in the Southern States of the United States and used wherever cotton-spinning mills exist. The cotton described commercially as **American** is suited to medium numbers of yarn; is usually clean, fairly regular in length of staple, satisfactorily graded, and consequently is one of the most reliable and useful cottons for a manufacturer's use. The quantity is greater than that produced in all other parts of the world together, and consequently the price of American cotton in Liverpool, which is the greatest market

for it, greatly influences the price of cotton throughout the world.

American cotton may be divided into three important classes; namely, *gulf cotton; uplands*, or *boweds;* and *Texas cotton.*

13. Gulf, or New Orleans, cotton usually consists of cotton raised in the basin of the Mississippi River, including the states of Louisiana, Mississippi, parts of Arkansas, and Alabama. The name gulf cotton is generally used in America and originates from the fact that most of this cotton is shipped from states bordering on the Gulf of Mexico. In Europe, the name New Orleans is usually applied, and is derived from the shipping port of that name. Gulf cotton is from 1 inch to $1\frac{1}{4}$ inches in length of staple, from .0004 to .0007 inch in diameter, and is generally used for yarn from 28s to 44s warp and from 50s to 70s filling or ply. This style of cotton may be subdivided into others, known as Memphis, benders, Allan-seed, Peelers, and so on. These names were originally intended to represent certain kinds of cotton, but have been very much misapplied of late years. The benders, or bottom-land, cotton is supposed to be grown at the bends of the Mississippi River, which are occasionally flooded and consequently well fertilized by the silt of the river. It is one of the better grades of gulf cotton, and is used for the higher numbers named above. The best qualities of gulf cotton are known as Allan-seed and Peelers. These are used for fine yarns, often for fine combed yarns, and by some spinners are preferred to Egyptian. The color is bluish-white rather than cream-colored, and somewhat resembles short Florida sea-island.

14. Uplands cotton is grown in the undulating country between the ocean and the mountains in the states of Georgia, North and South Carolina, Virginia, and Alabama. It is generally used for filling yarns below 40s, although it may be spun higher if required. The length of the staple is from $\frac{3}{4}$ to 1 inch and the fiber is from .0006 to .0007 inch in diameter. This cotton is usually very clean.

15. The cultivation of **Texas cotton** is largely on the increase, and for coarse warp yarn it is the most suitable cotton. In dry seasons, it is apt to be somewhat harsh and brittle and cannot be relied on as much as gulf or uplands cotton. The staple is usually from $\frac{7}{8}$ to 1 inch in length (sometimes exceeding this), and from .0005 to .0007 inch in diameter. Up to 26s and 32s warp yarns and 32s and 40s filling yarns are often made from Texas cotton, although it is eminently useful for warp. Indian Territory and Oklahoma cottons are of the Texas style.

Local circumstances often affect the use of cotton in the Southern States. A North Carolina mill may use an uplands cotton both for warp and filling, because of its being grown in the vicinity of the mill, although it is really a filling cotton; while a Mississippi mill may use local cotton for both warp and filling, although it is really too good for the latter, and so on.

BROWN EGYPTIAN COTTON

16. The cotton used in American mills is almost entirely grown in the United States, but in the fine-spinning districts a quantity of **brown Egyptian cotton** is used, and in the woolen mills some long, rough-stapled cotton, such as rough Peruvian, is in demand. The brown Egyptian cotton is generally used for warp yarns from 50s upwards, and filling yarns from 60s upwards intended for use in fine-woven cotton goods. Some of this cotton is also used for hosiery yarns and for the manufacture of Balbriggan underwear; in this case it is spun into lower numbers than those just mentioned.

Almost all the Egyptian cotton used in the United States is combed. The features of brown Egyptian cotton are the length of staple and fineness of the fiber, it being very silky and delicate in structure. The Egyptian cotton now grown is almost entirely of the so-called brown Egyptian type, being of a very light brown color.

TABLES OF COTTON CHARACTERISTICS

17. Four tables are printed herewith that have been gradually compiled during the last 20 years; they are the result of exhaustive observation and investigation. They give all the known cottons under their trade names and state where the cotton is grown, the length of the staple, the diameter in 10,000ths of an inch, the characteristics and appearance of the cotton, the numbers of yarn into which it is usually spun, and whether these yarns are for warp (twist), filling (weft), or ply yarns (doubling), with other information.

These tables are intended to indicate the numbers of yarns usually spun for commercial purposes. For special yarns that must be strong or of a high grade, the cotton may be used for lower numbers; or for special or local reasons, it may possibly be spun into higher numbers, or into warp, filling, or ply yarn, where not so specified, but these are unusual cases, and are not considered in formulating the tables.

The cottons are divided into four kinds: long-stapled, medium- to long-stapled, medium-stapled, and short-stapled.

GINNING AND BALING

18. Art. **3** gave a summary of the processes necessary for the cultivation of cotton, including cotton picking; but after it is picked, and before shipment to the mill, it must be ginned and baled. Seed cotton as it is picked contains about two-thirds of its weight in seeds; that is, out of 3 pounds of seed cotton, only about 1 pound is fiber.

THE SAW GIN

19. The gin commonly used in America for removing the fiber from the seed, except in the case of sea-island cotton, is the one known as the **saw gin.** Its construction may be briefly described as a series of revolving circular saws with

TABLE I

LONG-STAPLED COTTON

Trade Name	Where Grown	Length of Staple Inches	Diameter in 10,000ths of an Inch	Character of Fiber	Counts, or Numbers, of Yarn Generally Used for Ply Yarn	Remarks
Sea-island	Edisto, John, James, Port Royal, and St. Helena, S. C.; Cumberland and St. Simon, Ga.	$1\frac{3}{8}$ to $2\frac{1}{4}$	4 to 6	Silky, fine, strong, and clean	150s to 400s	Said to have been spun to 2,150s in London in 1851
Florida sea-island .	On mainland of Florida, near coast, from sea-island seed	$1\frac{1}{4}$ to $1\frac{3}{4}$	5 to 6	Silky and clean	150s to 200s	Good for lower grade sea-island yarn
Peruvian sea-island	On Peruvian mainland, from sea-island seed	$1\frac{1}{2}$	4 to 7	Silky and strong, but not clean	100s to 150s	
Fiji and Tahiti sea-island	Polynesian Islands, South Pacific Ocean	$1\frac{1}{2}$ to 2	4 to 6	Silky, strong, and clean	100s to 200s	Very rarely used and little grown
Bourbon	French Island, off coast of Africa	$\frac{3}{4}$ to $1\frac{1}{8}$		Weak		Very rarely used and little grown

TABLE II

MEDIUM- TO LONG-STAPLED COTTON

Trade Name	Where Grown	Length of Staple Inches	Diameter in 10,000ths of an Inch	Character of Fiber	Counts, or Numbers, of Yarn Generally Used for: Single Yarn, Warp	Single Yarn, Filling	Ply Yarn	Remarks
Brown Egyptian, or Mako	Lower, Middle, and Upper Egypt	$1\frac{1}{8}$ to $1\frac{3}{8}$	5 to 7	Golden brown to brown	50s to 100s	60s to 150s	70s to 150s	
Mitafifi	Lower and Middle Egypt	$1\frac{3}{16}$ to $1\frac{3}{8}$	5 to 7	Rich dark brown, long, strong, and fine				Principal variety
Ashmouni	Lower, Middle, and Upper Egypt	$1\frac{3}{16}$ to $1\frac{3}{8}$	5 to 7	Light brown, fine				
Bamia	Lower Egypt	$1\frac{1}{8}$ to $1\frac{1}{4}$	5 to 7	Brown and weak				
Abbasi	Lower Egypt	$1\frac{1}{8}$ to $1\frac{1}{4}$	5 to 7	Almost white, fine, and silky				Varies from season to season, not reliable
White Egyptian		$1\frac{3}{16}$	6 to 7	White				From American seed. Resembling gulf, or New Orleans, cotton. Very rarely seen
Gallini	Egypt	$1\frac{1}{4}$ to $1\frac{1}{2}$	5 to 6	White and silky			80s to 150s	From sea-island seed. Resembling Florida sea-island. Very rarely grown
Parahiba	Brazil	1 to $1\frac{3}{8}$	6 to 8	All Brazilian is harsh, wiry, clean, creamy colored, tree cotton	40s to 60s			The first two are about the best of Brazilian cottons
Maranhão					40s to 60s			
Ceara								
Aracaju					32s to 50s			All Brazilian cotton is good for warp yarns, especially yarns for heavy sizing. Gives strength when mixed with American
Rio Grande					32s to 50s			
Pernambuco					32s to 50s			
Bahia					32s to 50s			
Maceio					32s to 50s			
San Paulo					32s to 50s			

TABLE II—(Continued)

Trade Name	Where Grown	Length of Staple Inches	Diameter in 10,000ths of an Inch	Character of Fiber	Counts, or Numbers, of Yarn Generally Used for			Remarks
					Single Yarn		Ply Yarn	
					Warp	Filling		
Santos	Brazil				32s to 50s			American seed
Rough Peruvian	Peru	$1\frac{1}{4}$ to $1\frac{1}{2}$	6 to 8	Rougher than Brazilian	40s to 70s			Some very weak and high color
Surinam, Berbice; Cayenne, Demerara	British and French Guiana	$1\frac{1}{8}$ to $1\frac{3}{8}$		Smooth and fine	Said to spin 160s			Very little grown or used
Guatemala	Central America	1 to $1\frac{1}{8}$		White and clean				Resembles the cotton from Guiana
Santo Domingo, or Hayti; Puerto Rico; Anguilla	West India Islands	1 to $1\frac{1}{2}$	6 to 8	Smooth, glossy, and clean; variable	Said to spin 120s			Very little grown or used
Catamarca; Santa Fé; Salta	Argentine	$\frac{7}{8}$ to $1\frac{1}{4}$		Reddish				
San Luis	Argentine	$1\frac{1}{8}$ to $1\frac{5}{8}$		Reddish				
Rioja; Paraná	Argentine	1 to $1\frac{1}{2}$		White				
Hawaii	Hawaiian Islands	1 to $1\frac{1}{2}$						

TABLE III

MEDIUM-STAPLED COTTON

Trade Name	Where Grown	Length of Staple Inches	Diameter in 10,000ths of an Inch	Character of Fiber	Counts, or Numbers, of Yarn Generally Used for Single Yarn Warp	Counts, or Numbers, of Yarn Generally Used for Single Yarn Filling	Remarks
AMERICAN COTTONS							
Gulf cotton, or New Orleans	Mississippi, Louisiana, and neighboring states	1 to 1¼	4 to 7		28s to 44s	50s to 70s	
Benders, or bottom-land	Mississippi River bottom, Louisiana, and Mississippi				28s to 44s	50s to 70s	A variety of gulf, or New Orleans, cotton
Peelers	Varieties originated in Mississippi and grown usually in Mississippi, Louisiana, Arkansas, and Alabama			Bluish-white usually	28s to 44s	50s to 70s	Somewhat resembles short Florida sea-island
Allan-seed				Long staple	28s to 44s	50s to 70s	Ranking among best of New Orleans cotton, usually bad to card
Uplands	Georgia, North Carolina, South Carolina, and Virginia	¾ to 1	6 to 7			30s to 40s	A clean, easily manipulated, useful cotton, suitable for filling
Texas	Texas	⅞ to 1	5 to 7		Below 32s	Below 40s	Suited for warp
Georgia	Georgia					Below 40s	A variety of uplands
Mississippi, or Louisiana	Mississippi or Louisiana				Below 32s	Below 40s	Varieties of gulf cotton
Selma	Alabama			Generally very clean	Below 32s	Below 40s	Variety of gulf cotton
Arkansas	Arkansas				Below 32s	Below 40s	Variety of gulf cotton
Boweds					Below 32s	Below 40s	Another name for uplands
Memphis	Alabama			Generally good staple but leafy	Below 32s	Below 40s	Variety of gulf cotton
Norfolk	North Carolina and Virginia			Generally very clean	Below 32s	Below 40s	Variety of boweds, or uplands
Savannah	Georgia			Generally clean	Below 32s	Below 40s	Variety of boweds, or uplands

TABLE IV

SHORT-STAPLED COTTON

Trade Name	Where Grown	Length of Staple Inch	Diameter in 10,000ths of an Inch	Character of Fiber	Counts, or Numbers, of Yarn Generally Used for — Single Yarn — Warp	Counts, or Numbers, of Yarn Generally Used for — Single Yarn — Filling	Remarks
INDIAN COTTONS							
Comptah	Central Provinces	$\frac{3}{4}$ to $\frac{7}{8}$	7 to 9		14s and below	18s and below	Dirty
Hinghunghat	Central Provinces	1 to $1\frac{1}{8}$	7 to 9				Very seldom used
Oomrawattee	Berars in Central India	$\frac{7}{8}$ to 1	7 to 9	Good color, cleaner than Dhollera	18s and below	24s and below	Dirty
Dharwar	Bombay Pres. Extreme South.	$\frac{3}{4}$ to 1	7 to 9	Neppy	14s and below	20s and below	
Scinde	Extreme Western India, Province of Scinde	$\frac{5}{8}$ to $\frac{7}{8}$	7 to 9		6s to 12s	6s to 12s	
Broach	Bombay Pres. Western coast	$\frac{3}{4}$ to $\frac{7}{8}$	7 to 9	Soft fiber and high color	14s and below	22s and below	
Khandesh	Bombay Pres.	$\frac{5}{8}$ to $\frac{7}{8}$	7 to 9				
Bilatee	Bombay Pres.	$\frac{5}{8}$ to $\frac{7}{8}$	7 to 9				
Dhollera	Bombay Pres.	$\frac{7}{8}$ to $1\frac{1}{16}$	7 to 9	White, and has considerable dirt	16s and below	24s and below	
Surat	Port, Bombay Pres. Dist. of Broach						A name given to all Bombay Presidency cotton
Tinnevelli	Presidency of Madras	$\frac{3}{4}$ to 1	7 to 9	Creamy	18s and below	24s and below	
Western	Western Madras	$\frac{5}{8}$ to $\frac{7}{8}$		Dirty	Very low numbers	Very low numbers	
Bengal	Bengal Pres.	$\frac{1}{2}$ to $\frac{5}{8}$	7 to 9	Tinged, dirty, weak fiber	4s to 8s	4s to 10s	Dirtiest cotton grown
Dacca	Bengal Pres.	$\frac{1}{2}$ to $\frac{3}{4}$	7 to 9	Short, harsh, rough staple, not very clean, often tinged	6s to 8s	6s to 12s	Resembles wool
Coconada	India	$\frac{1}{2}$ to $\frac{5}{8}$	7 to 9	Red color, weak, irregular, and dirty	4s to 6s	4s to 10s	
Red Northern							A high-colored variety of Indian cotton
Assam	Northeastern India	$\frac{1}{2}$ to $\frac{3}{4}$		Dull appearance, harsh, stiff fiber, and fairly clean	6s to 10s	6s to 16s	Resembles wool

TABLE IV—(Continued)

Trade Name	Where Grown	Length of Staple Inch	Diameter in 10,000ths of an Inch	Character of Fiber	Counts, or Numbers, of Yarn Generally Used for		Remarks
					Single Yarn		
					Warp	Filling	
Other Asian Cottons							
China and Corea		$\frac{1}{2}$ to $\frac{3}{4}$		Rough, but very clean	6s to 10s	6s to 14s	
Camilla	China	$\frac{1}{2}$ to $\frac{3}{4}$		Bright, very clean, harsh, and rough	6s to 14s	6s to 14s	A variety of China
Turkestan. Indigenous	Central Asia (Russian provinces)	About 1		Rough, good color, and clean			
Turkestan. Exotic	Central Asia (Russian provinces)	About 1		Smooth, good color, and clean			From American seed
Japan	Japan	$\frac{5}{8}$ to $\frac{3}{4}$		Very clean			
Philippine	Philippine Islands	$\frac{5}{8}$ to 1		Clean and smooth			
Java	Island of Java	$\frac{3}{8}$ to $\frac{5}{8}$		Weak and dirty	4s to 6s	4s to 6s	
Persian	Persia	$\frac{3}{4}$ to $1\frac{1}{16}$		Bright, creamy color, leafy, and strong			Resembles, but is superior to, the best Indian
Smyrna	Asia Minor	$\frac{5}{8}$ to 1		Creamy, dull, and leafy			
Sundry Cottons							
Nankin	United States	$\frac{3}{4}$	4 to 7	Clean, high color, weak staple			Not now grown
African	Liberia and West Coast	About 1		High color and irregular			Somewhat resembles Brazilian
Greek	Greece	$\frac{1}{2}$ to $\frac{3}{4}$		Short and brittle			
Caucasian	Caucasia	$\frac{7}{8}$ to 1		Brown and smooth			
Queensland	Australia	$\frac{7}{8}$ to 1					
Clarence River	Australia	$\frac{7}{8}$ to 1		Clean			Gray seed
Mexican, including Yucatan, Laguna, Campeche, and Oaxaca	Mexico	$\frac{3}{4}$ to 1		Clean, creamy, not very strong			
Cyprus	Island of Cyprus						Very little grown
Malta	Island of Malta						Very little grown
Turkish	Bulgaria	$\frac{3}{4}$ to 1		Dull color			
Italian	Neighborhood of Naples	$\frac{3}{4}$					Very little grown
Sicilian	Island of Sicily	$\frac{3}{4}$					Very little grown

fine teeth, so placed that an arc of their circumference projects through a grid into a receptacle containing the seed cotton. The lint is torn from the seed and carried through the grid by the saws, from which it is removed by a brush and carried to a condenser.

Fig. 6 is a section through a gin, one of the saws being marked *d*. The seed-cotton receptacle, or seed box, is marked *a*; *c* is the saw cylinder on which the saws are fixed; *e* shows the grate through which the saws project, known as

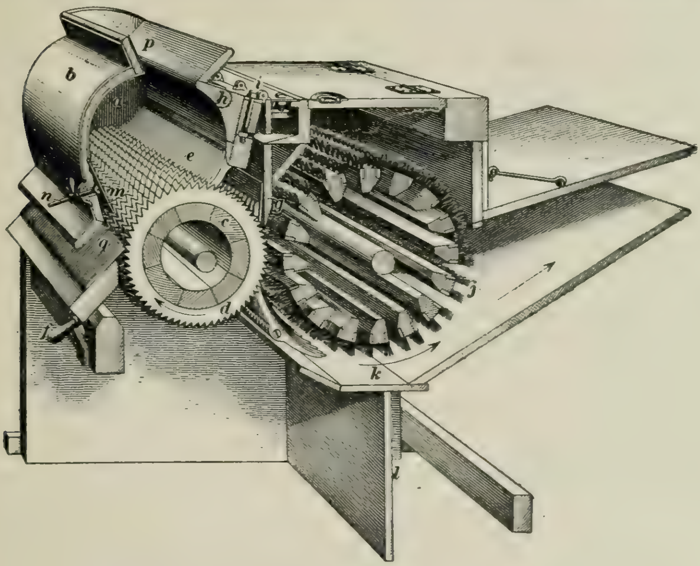


Fig. 6

the breast, or grate fall. The chamber *a* is full of seed and seed cotton. The seed cotton is on the outside of a core of seed and is thus brought within the operation of the saws.

The seed cotton, having been fed into the chamber *a*, passes around on the outside of the mass of seed. The teeth of the saws, projecting through the grid about $\frac{1}{2}$ or $\frac{3}{4}$ inch, tear the fibers from the seeds nearest to them. The quick speed of the saws (about 350 revolutions per minute) sets up a rolling motion of the mass of seed, for which

reason the chamber *a* is sometimes called the *roll box*. New seed cotton is continually being brought under the action of the saws, being fed in at *p*, while the seed when freed from its fiber drops, at *q*, to the floor. The fibers are carried forwards by the revolution of the saws and are removed by a rotary brush.

The circular brush, shown at *j*, Fig. 6, is an important part of the machine; it should be filled with heavy bristles and the framework and ribs should be strongly constructed and well bound together. The brush makes four or five times as many revolutions per minute as the saws, in the direction indicated by the arrow below it, Fig. 6, and the cotton is either blown into a lint room, on the old system, or, where a condenser is used, the fibers are drawn forwards by the air-current to the surface of wire-covered drums or screens; by passing between these screens they are delivered in the form of a sheet, being deposited on the floor in the case of gins that are not connected to a conveyer.

The gins most frequently used have from sixty to eighty saws, which are either 10 or 12 inches in diameter. The highest speed that 12-inch saw cylinders should be driven for good work is 300 revolutions per minute, although they are frequently detrimentally run up to 400 revolutions per minute and above. A suitable production for a 60-saw gin is one bale of 500 pounds per hour.

THE ROLLER GIN

20. A type of gin used both for long- and short-stapled cotton in many parts of the world—as exemplified by its almost exclusive use in Egypt, where long-stapled cotton is grown, and in India, where the cotton is almost all short-stapled—is the **roller gin.** There is not much doubt that the roller gin separates the fiber from the seed with a very much easier action than the saw gin, but it has not been adopted in the United States to so large an extent as it should, being used principally in the sea-island districts, and even there only to a limited extent. The reason for this is

that the production of the machine is not so great as that of the saw gin.

There are at least two distinct types of construction of roller gins in general use, but both of them depend on the same principle for the removal of the fiber from the seed, which is to draw the fiber between a rapidly revolving roll and a sharp knife edge resting against this roll, so that the fibers are cut off near the point of attachment to the seed. The usual method is to place the seed cotton on a table or hopper, from which it is gradually fed into a seed box and presented to a roll covered with heavy hide that has a roughened surface. A stout knife extends across the machine near the revolving roll, its edge being parallel with the shaft on which the roll is mounted. The fine fibers adhere to the leather covering of the roll, and are drawn between it and the knife until the seed is pulled against the edge, when the fibers are severed from it. The same seed is continually drawn against this knife edge by different fibers attached to its surface, until it is entirely stripped, when it falls down and another seed takes its place. The cotton is being constantly removed from the surface of the leather roll.

In order to agitate the seeds and aid in the removal of the fibers as they pass between the knife and the roll, two methods are adopted, and this difference of construction characterizes the leading types of roller gins.

21. In what is known as the **knife-roller gin,** a roll with **V**-shaped or angularly set knives is rotated in front of the leather roll, and on account of the angle at which the knives are set, pushes the seeds from side to side and agitates them sufficiently to aid in stripping the fibers from them by presenting new surfaces of each to the stripping knife, until it is absolutely stripped of fiber.

22. In another type of gin, known as the **Macarthy gin,** a vertical knife mounted on a connecting-rod attached to a crank is given a reciprocating motion, and thus effects the same object. In what is known as the double Macarthy

gin there are two of these knives operated by a double crank below the machine.

23. All roller gins require considerable care in operation, especially with regard to maintaining a true surface on the leather rolls and an even pressure of the stripping knife on the roll at all points, as well as a proper adjustment of the blades of the knife roller in the knife-roller gin, or of the vertical knives in the Macarthy gin. The Macarthy gin has a production of about 350 pounds of ginned cotton in a day of 10 hours from the single gin, or 500 pounds in a day of 10 hours from the double gin, and absorbs from 1 to $1\frac{1}{2}$ horsepower. The knife-roller gin has a production of 800 to 1,000 pounds in a day of 10 hours, and requires $2\frac{1}{2}$ horsepower to drive it.

BALING

24. After ginning, the cotton is baled. This is done by enclosing it in a baling press with an outside wrapper of coarse burlap, in which it is pressed into comparatively small compass and held by iron ties.

The bales as they come from the farms or the cotton gins are too large for economical shipment either by railroad or steamship. Consequently, at every inland city and seaport in each cotton state there are compresses. These are powerful steam baling presses, in which the cotton bale can be reduced to smaller dimensions.

Previous to compressing, the exporters affix a tag to each bale by which to identify it, and take from each bale a sample, which is numbered the same as the tag. The samples are then graded and assorted into lots of low middling, middling, good middling, and so on, as will be explained, and then shipped (usually in lots of 100 bales) either to Northern mills or to Europe.

MARKETING COTTON

SELECTION AND CLASSIFICATION

25. The selection of cotton from samples, or the judging of cotton, is a matter of considerable importance. In order to become thoroughly proficient, a long period of practice is required to produce the trained eye and hand necessary to distinguish the gradations and differences in quality that add to, or detract from, the market value of the fiber. This is not of so much importance in the Southern markets, where the bales are usually on hand to be referred to in case of dispute, but in the Northern states, and in any country where cotton is largely purchased from samples, it is of the utmost importance.

26. Samples.—Cotton is seldom, if ever, purchased from the examination of the bale, but from parcels containing small pieces of cotton from each bale, technically known as **papers of samples.** It is customary in well-managed mills to take samples of each new lot of cotton that arrives at the mill, sometimes a sample from every bale, and at other mills only from a certain number of bales out of each hundred. The samples are then compared with the buying samples to see if the cotton is equal to the quality purchased.

27. Points to Be Considered in Judging Cotton. In judging cotton from a sample, or in selecting cotton from a sample with a view to purchasing it, the first thing to do is to investigate the authenticity of the sample. The points then determined are: (1) the grade of the sample, (2) the staple, (3) the color, (4) the amount of sand, (5) the amount of dampness, (6) whether the cotton is even running or not. These points are arranged in order of their usual importance.

This is not necessarily accurate enough for some purposes;

for instance, in cotton to be used for filling yarns, the color is more important than in cotton for warp yarns. As the warp yarn has to be sized, the appearance of a good-colored cotton is somewhat spoiled, while on the other hand defects of a dull-colored cotton are hidden. In either case, the length of staple may be the most important point to consider where it is desired to produce a strong yarn without regard to its appearance.

28. Grade.—American cotton is usually graded according to a standard agreed on in all the leading cotton markets of the world, the highest grade being *fair*, followed by six other grades, the lowest being *ordinary;* cotton of lower grade is called *inferior*. The seven full grades of American cotton are *fair*, *middling fair*, *good middling*, *middling*, *low middling*, *good ordinary*, and *ordinary*.

This gradation is not sufficiently fine for the cotton merchant, and consequently each grade is subdivided into what are known as half grades and quarter grades. By this means a list is made up giving twenty-six different grades of cotton. This list is as follows:

Fair, barely fair, strict middling fair, fully middling fair.

Middling fair, barely middling fair, strict good middling, fully good middling.

Good middling, barely good middling, strict middling, fully middling.

Middling, barely middling, strict low middling, fully low middling.

Low middling, barely low middling, strict good ordinary, fully good ordinary.

Good ordinary, barely good ordinary, strict ordinary.

Ordinary, low ordinary, inferior.

Those terms having the word *strict* are the half grades, while those having the words *barely* and *fully* are the quarter grades. The full grades are printed in bold-face type.

Grade really means the appearance of the cotton as

regards cleanliness, and the above system of grading depends on the appearance of the cotton as to its freedom from leaf and other impurities. Some graders take into consideration what is known as *bloom*, or *brightness*, of the cotton, which adds to the grade; also, discoloration, known as *off color*, or *tinges*, which detracts from the grade.

29. Staple.—After determining the grade, the next thing to do is to find the staple. The word **staple** usually means the average length of the bulk of the fibers forming the bale assessed, and is found by taking a small portion of cotton in the way hereafter described, preparing a tuft of fibers from which the very short fibers have been removed, and then measuring the average length of fibers remaining. Cotton is spoken of by the length of staple; thus, 1-inch cotton, $1\frac{1}{4}$-inch cotton, and so on. There is something more that is usually implied by the word staple—strength of the fiber. This is determined by holding one end of the tuft between the first finger and thumb of each hand and breaking it. The word staple may therefore be taken to mean the average length of the fibers forming the bale, and may also be understood to include the strength of the fibers; thus, the expressions *length of staple* and *strength of staple* are obtained.

An expert cotton sampler or buyer will often judge cotton by simply taking a tuft and giving it one pull, judging it by the amount of drag or cling that must be overcome in pulling it apart. He thus tests both the length and strength of the staple at the same time. This skilfulness comes only with experience, but is the most rapid method of judging cotton.

30. Sand and Dirt.—After the staple has been determined, it is necessary to discover the amount of sand and dirt in the cotton. This is often done by raising the cotton from the paper that holds it and noticing the amount of sand remaining on the paper, this sand having fallen out by the repeated handling of the cotton. It is, perhaps, better to hold the handful of cotton as high as one's head and shake it so that the sand, if there is any, can be seen to fall from it.

31. Dampness.—Another test is that for dampness. This can only be detected in the sample paper if the samples are newly drawn, in which case it can be felt by the hand. If the samples have been in stock for some time, the water originally contained in them will have evaporated and cannot be ascertained unless it has previously been so great as to cause a slight formation of mildew on the cotton, in which case it is indicated by the smell.

32. The rich, bright, creamy appearance that cotton has, especially in the early part of the year, is called the **bloom.** This bloom is only found on certain growths of cotton and adds somewhat to its value, especially where it is to be used for making weft, or filling, yarn, or where the goods into which it is to be made are to be sold in their unbleached or undyed state, technically known in Europe as *in the gray*, and in some parts of America as *brown goods.*

Tinges, high color, or off color, should be looked for. These are caused where the cotton has become tinged while on the plant, through rain stains, or by having fallen on the ground and become mixed with some of the red clay of the cotton field. These bales should be avoided, and in case of purchasing from a sample containing indications of having come from tinged bales, an agreement for a reduction in price on the bales ought to be arranged, or a condition made that these bales be thrown out before shipment of the quantity purchased.

33. The last point, and one that is important, is to see that all bales are somewhat alike. Usually a sample paper is made up of a handful of cotton from each of the lot of bales; by testing first one sample and then another it is discovered whether the lot of cotton is even running. Occasionally, however, if not graded properly by the cotton factor, a lot of cotton is found to be mixed; some bales may be higher grade than others, some may be longer-stapled than others, and even in the same bale an abnormal variation in length and strength of staple may be found. Cotton of this kind should be avoided altogether, as it is almost impossible to make satisfactory yarn out of cotton mixed in this manner.

34. As has been stated, constant practice is necessary to become a good judge of cotton. Even experienced cotton graders and cotton buyers improve year by year in their judgment of the fiber, until some of them, by a quick glance or the slightest touch, can determine at once whether the cotton is suitable for their purposes or not. It is not an unusual thing for a cotton buyer in a market like Liverpool to become so expert as to be able to examine in a single day type samples representing tens of thousands of bales.

Usually the grade is mentally determined; then a small handful of cotton is grasped by both hands, having the thumbs uppermost, and pulled apart. One-half is thrown away, and the ends of the fibers that project from the other piece are grasped between the thumb and the first finger of the right hand, and the left hand is employed in removing short fibers, or *fud*, from the tuft. The tuft of cotton, now much lessened in size, is grasped by holding the other ends of the fibers in the left hand, while the right hand removes more short fibers, or fud. By these few quick movements an experienced cotton sampler has arrived at a small tuft of fibers laid parallel, which can first be measured, usually with the eye only, and afterwards grasped firmly between the first finger and the thumb of each hand, the thumbs being uppermost, and broken by a short, strong pull. By always taking the same amount of cotton in the hand at once, and reducing it to the same-sized tuft, the cotton sampler fixes a standard of length and strength for himself, by which he can assess the value of almost any kind of cotton.

An accurate judgment of the length of staple can only be acquired by experience and practice, and a uniform method should be cultivated. By removing all short fibers and retaining only the longest ones for measurement, too long a measurement is obtained. This is often done by those interested in the sale of the cotton. By throwing out the long fibers and measuring the shortest ones, the length obtained does not fairly represent the staple of the cotton. A cotton sampler who wishes to give an impartial judgment will throw out all the shortest fibers, or the fud and the waste, and also

the longest fibers, which are evidently unrepresentative of the bulk of the cotton, leaving a bunch of fibers fairly even in length and typical of the majority of the fibers in the bale. These fibers are then measured.

35. After the grade and staple have been determined in the manner just named, a test is made for sand and for uneven running; the appearance as to bloom, color, and evidences of gin damage is then noticed, completing the test of the cotton, by which time a cotton expert should have made a mental estimate of its value.

In regard to gin damage, it should be stated that this often occurs when cotton is ginned on the saw gin while damp; it is also caused if the gin is operated at too high a speed. Cotton in this condition can be recognized by being curled and stringy, with the fiber broken or cut.

Another point to be noted in this connection is that local circumstances often affect the judgment on a lot of cotton; for instance, a good north light is the best in which to judge cotton, as this light is more regular than any other. Cotton should not be purchased from a sample wrapped in paper with a blue lining, unless it is removed for examination, as this causes the cotton to appear better than it really is.

COTTON MARKETS OF THE UNITED STATES

36. The largest crop in any of the states is raised in Texas, and this makes Houston one of the most important interior markets of the United States. In the season of 1899–1900, 550,000 bales of cotton were sold in this market, which amount was excelled only by the gulf port New Orleans, where 1,002,000 bales were sold in the same season. Memphis, on the Mississippi River, is a market of importance and is a great center for long-stapled cotton. In the season referred to, 477,000 bales were handled at Memphis and 267,000 at Augusta, Georgia.

Among other important cotton markets are Savannah, Georgia; Charleston, South Carolina; Mobile, Alabama; St. Louis, Missouri; Shreveport, Louisiana; Vicksburg

and Columbus, Mississippi; Macon, Columbus, and Rome, Georgia; Selma, Montgomery, and Eufaula, Alabama; and Nashville, Tennessee.

MILL PURCHASES OF COTTON

37. The cities of Boston, Providence, New Bedford, and Fall River are important markets for cotton, as many of the Southern factors have agents or branch offices at these points. In the fall, the salesmen of these houses, together with special agents who are sent from the cotton belt, are very busy in offering cotton to the manufacturers, who buy large quantities from October until March. The treasurers of the mills are usually the cotton buyers, and they select cotton from the samples that have been sent from the cotton factor, showing the style of cotton that he is offering. Practically the whole of the cotton required for a year is purchased in the period named above, and very frequently it is shipped North immediately after the sale takes place. Arrangements are occasionally made for the shipment of so many bales per month.

Money can be borrowed at very much lower rates of interest in New England than in the South, and consequently it is much cheaper to carry or hold cotton in the North, as in most cases the parties hold it on behalf of the banks that have loaned money to enable them to carry it. For this reason most of the large cotton-manufacturing establishments of New England have very large storehouses connected with their mill buildings, and the winter is usually a very busy time in receiving this cotton, and weighing, sampling, and storing it for future use

The terms on which Northern manufacturers buy cotton are very simple. Usually the cotton is sold on cash terms, with no discount being allowed and no allowance being made for bags or ties, the gross weight being invoiced. The cotton is usually purchased delivered in Boston or an equivalent point, a freight rate allowance being made by the shipper equal to the amount that the manufacturer pays for the freight on arrival of the cotton. It will be seen that the

above system requires that a very large stock of cotton be kept at the mills for a considerable portion of the year.

While the above system is a general one, there are special cases in which the cotton is purchased as needed; in these cases it is not unusual for manufacturers to send mail orders to reliable Southern houses that know what grade of cotton they are accustomed to use, specifying the length of staple, grade, and style of cotton, and leaving it to the Southern merchant to ship the quality of cotton desired. In cases of this kind, cotton is said to be bought on description; that is to say, the mill will purchase cotton, simply stating that it is to be of a certain grade and certain length of staple; for instance, 100 or 1,000 bales good middling $1\frac{1}{4}$ inches.

EXPORTATION OF COTTON

38. The exports of cotton and its products from the United States in the fiscal year ending 1901 exceeded the export value of any other class of exports, averaging $1,000,000 per day throughout the year. The actual figures are as follows:

Cotton, raw	$313,673,443
Cotton manufactures	20,272,418
Cottonseed oil	16,541,321
Cottonseed meal	13,119,968
Cotton waste	1,431,604
Cottonseed	366,953
Total	$365,405,707

PICKERS

(PART 1)

YARN-PREPARATION PROCESSES

INTRODUCTION

1. Condition of Stock.—The condition in which the raw cotton reaches the cotton mill is that of a compressed bale. In a few sections in the United States and in some foreign countries where cotton mills are located in close proximity to the cotton fields, the cotton is delivered to the mill in a loosely packed bale that has not been compressed, and in some cases even as loose cotton taken from the cotton gin to the mill without baling. Instances of this kind are very rare, however, compared with the general method of delivering cotton in the form of a compressed bale, which is the condition that will be accepted as a standard. A compressed bale of cotton is a matted mass of innumerable fibers lying in all directions, with which are intermixed sand, broken leaf, sticks, broken seed, and other foreign matter. The fibers themselves, although approximately of the same quality, are not, even in the same bale, exactly of the same length, nor are they all ripened to the same point of maturity, while some of them may have been cut by the action of the gin, or rolled into *neps;* that is, into small bunches of closely matted and tangled fibers that have the appearance of specks in the cotton and, while varying in size, are generally very minute, rarely being larger than an ordinary pin head.

2. Object of Cotton-Yarn Mills.—From this material, it is the object of the cotton-yarn mill to produce a clean, smooth, even thread from which all foreign matter has been removed, and which consists only of the perfect, or approximately perfect, fibers, the neps and excessively short fiber having been thrown out. In order to produce a comparatively strong thread, the fibers not only must be cleaned, but must be arranged approximately parallel to each other and assembled by a system in which a loose strand or ribbon of fibers is produced, which is gradually attenuated until it arrives at the correct fineness, when it is twisted to give it strength, and in that condition is spoken of in the cotton manufacturing business as **yarn.** This, then, in general, is the object of the cotton-yarn mill—to produce from the bale of raw cotton as large a percentage as possible of cotton yarn, which should be smooth, clean, even, and strong.

One pound of cotton must be spun into yarn of which there is seldom less than 1 mile to a pound, usually 10 miles or even a greater length than this; and in some cases, for special purposes, there may be 100 miles or more. The problem is not only a mechanical one, but one involving a constant study of economy and also aiming at an excellence of production as far as is consistent with the proper economical operation of the yarn mill.

PROCESSES EMPLOYED FOR PRODUCTION OF COTTON YARN

3. In order to produce cotton yarn, the fiber is passed through a number of processes, varying from ten in a mill manufacturing coarse yarns to fifteen in one making fine yarns. These processes may be divided into three classes, as follows: (1) mixing; (2) cleaning; (3) parallelizing and attenuating. In this classification, those processes that follow the spinning are of course ignored, although in a mill making yarn for sale, a fourth class might be made of processes for preparing the yarn for the market.

4. Yarn is spoken of as being *coarse*, *medium*, or *fine*, according to the thickness of the thread, and this in turn is determined by the number of hanks to the pound. A hank of cotton yarn contains 840 yards, and the size of the yarn is indicated by the number of these hanks required to weigh 1 pound; thus, 10s yarn would contain 10 hanks, or 10×840 yards, making 8,400 yards, in a pound; 40s yarn would contain 40 hanks, or 33,600 yards, in a pound. The higher the numbers, that is, the greater the number of hanks in a pound, the finer is the yarn.

No arbitrary rule can be given for determining which is coarse yarn, which is medium, or which is fine, as a manufacturer accustomed to making only coarse yarn might consider 30s fine, while another manufacturer engaged principally in the use of fine yarns would consider 30s coarse. A general classification would be to consider yarns below 30s as coarse; from 30s to 60s as medium numbers; and above 60s as fine yarns. The expression *low numbers* is sometimes applied to coarse yarns, and *high numbers*, to fine yarns. The number of a given yarn is commonly spoken of as its *counts;* thus, it is said that the counts of yarns are 10s, 12s, 36s, etc.

5. The processes adopted in different mills vary according to whether the mills are intended for coarse, medium, or fine yarns. A mill making medium yarns, for instance about 32s, would in most cases use the following machines: automatic feeder, opener, breaker picker, intermediate picker, finisher picker, card, first drawing, second drawing, third drawing, slubber, intermediate, roving frame, spinning frame. In cases where the railway head is used, it comes between the card and the first drawing; in this case the third drawing is omitted. Where the bale breaker, or cotton puller, is used, it takes a position before the automatic feeder. Where the mule is used, it takes the place of the spinning frame.

For coarser numbers, the above list is changed by omitting one or more of the parallelizing and attenuating processes, and sometimes adding a cleaning process. In changing the

list to suit finer yarns, the reverse is the case; one cleaning process, or more, is omitted and attenuating processes are added, but for very fine yarns, a cleaning process, namely, combing, is added.

Below will be found combinations of machinery suitable for mills making various numbers.

6. The machinery for yarn mills making 10s and below is as follows: automatic feeder, opener, breaker picker, intermediate picker, finisher picker, card, first drawing, second drawing, slubber, roving frame, spinning frame. The railway head may be used instead of the first drawing process.

The machinery used in yarn mills making about 100s is as follows: automatic feeder, opener, breaker picker, finisher picker, card, sliver-lap machine, ribbon-lap machine, comber, first drawing, second drawing, third drawing, fourth drawing (optional), slubber, first intermediate, second intermediate, roving frame, mule. Sometimes a drawing process is used between the card and the sliver-lap machine. Where four processes of drawing are used, the roving frame is not necessary, and where four processes of fly frames (slubber, first intermediate, second intermediate, and roving frame) are used, it is not always necessary to have more than three processes of drawing.

The machinery used in yarn mills for making 200s is as follows: automatic feeder, opener, breaker picker, card, sliver-lap machine, ribbon-lap machine, comber, first drawing, second drawing, third drawing, fourth drawing, slubber, first intermediate, second intermediate, roving frame, mule.

The names given to the fly frames vary in different sections, and in some places they are known as slubber, intermediate, roving frame, and jack frame.

7. What are known as *double-carding processes* were formerly very often employed, but are now going out of use both for coarse and fine yarns. Any of the preceding combinations can be converted into double-carding combinations by adding after the card the names of derby doubler and finisher card.

8. It is advisable to carefully study the combinations just given, noticing the difference between one combination and another, and becoming thoroughly familiar with the order in which the machines are mentioned, so that a knowledge of the accurate sequence of processes may be obtained. While the foregoing combinations of machinery are reliable and may be considered as the standards for the class of work to which they refer, it occasionally happens that mills are found using different layouts. This may be because the mill is intended to make a lower or a higher grade of yarn than is customary for the numbers referred to, or because it is a mill that has been changed over from other numbers and the old machinery has been retained; or there may be many other reasons.

Different opinions are held among millmen and mill engineers as to the proper equipment for mills. In this connection, as well as in regard to all other statements concerning cotton-mill machinery—especially as to its construction and operation—it may be said that there is perhaps no industry in which so much variety of opinion will be found regarding the best methods of arriving at certain objects as in the cotton-mill business. Not only do differences of opinion arise among manufacturers, but a machine builder frequently looks at a problem from a point of view differing from that of a manufacturer. He looks on a machine or a process as a mechanical problem to be solved, while a manufacturer looks at it as a problem to obtain certain results effectively and economically. Again, American practice differs considerably in some respects from European methods. For these reasons it is almost impossible to give definite statements of the customary use and practice accepted by all millmen, and therefore the statements made are in every case, as far as possible, either what has been found from experience to be correct, or what the majority of manufacturers would accept as being accurate, according to American practice.

9. A thorough comprehension of the principles of cotton-yarn preparation can best be obtained by a careful study of

each machine or process in its proper sequence, including the objects of the machine, the principle on which it is constructed, and the mechanism employed to arrive at its objects; and by considering the operation and management of the machine not only theoretically, but from actual observation. In doing this, the desired knowledge will be obtained sooner if the combined objects of all cotton-yarn-preparation machines are borne in mind: (1) the separation of the matted mass of fiber into loose flakes and the removal of the heavier and more bulky impurities, which objects are principally attained in the opening and picking processes; (2) the further cleansing of the stock from light and minute particles of foreign matter by such means as are adopted in the carding and combing processes; (3) the parallelizing, evening, and attenuation of the fibers, as performed in the carding and drawing processes, in the fly frames, and in the spinning process; (4) the strengthening of the product by twisting, as exemplified in ring or mule spinning.

COTTON MIXING

10. Receipt of Cotton at the Mill.—If cotton is received at the mill in large quantities, as is usually the case, it must necessarily be stored until it is required for use. Before storing, however, it should be carefully ascertained whether the quality of the cotton in each bale is equal to the quality of the sample from which it was bought. After this has been accomplished, all the bales of one kind, grade, and staple (approximately) should be placed together in the storehouse, irrespective of their original marks.

11. Objects.—When a new lot of cotton is to be used, as many bales as it is desired to mix at one time are taken from the storehouse to the **mixing room,** where the cotton is mixed. The objects of mixing the cotton from a number of bales are: (1) to allow the cotton to assume its normal condition; (2) to establish an average quality of grade in the lot. As regards the first object it should be understood that cotton when compressed is subjected to great pressure—

so much so that the space occupied by seventy uncompressed bales is often equal to that occupied by one hundred that are compressed. Cotton, when in this compressed state, cannot be worked so advantageously as when in its normal condition, and for this reason should be allowed to stand for some time after being opened before it is used.

As regards the second object of mixing, it may be stated that, theoretically, to make a perfect product, all the fibers should be of the same length, diameter, strength, cleanliness, and color; in other words, they should be equally matured and grown under the same conditions.

It is impossible, however, to obtain a large quantity of cotton that will not vary in quality, because the lot is made up of cotton collected from various plantations, which are probably some distance from each other and subject to different climatic conditions, different methods of cultivation, different seed and soil. The result is that the cotton from the plantation where the conditions were most favorable is in a higher state of maturity than that raised on the other plantations. Even in bales from the same plantation a variation is found. An experienced cotton sampler can find points of difference—slight in many cases, but still variations—in almost every bale of each lot of cotton. In order to neutralize this variation as much as possible and insure a continuance of a supply of even-running stock over as long a period as possible in the mill, mixing the bales is resorted to.

12. Size of the Mixing.—The quantity of cotton used in a mixing should be as large as possible; for the larger the mixing, the easier it is to keep the work regular for a considerable length of time. The reason for this is that no two mixings are alike, this being due not only to the variation found in different bales of the same kind, but also to atmospheric changes that affect the cotton, especially in regard to moisture. In addition to securing regularity, another reason for having large mixings is to give cotton from compressed bales an opportunity to expand. By making a large mixing and allowing it to stand for some days in a room, the temperature

and humidity of which are about the same as those of the room in which the cotton is to be worked, it will be found that the stock will run much more evenly, make less waste, and produce a stronger yarn than when used directly from the bale.

13. Method of Mixing.—Mixings when made by hand should occupy a considerable amount of floor space. The first bale should be spread over all this space, the second bale spread to cover the first, the third to cover the second, and so on. By this means the mixing is built up of layers from each bale of cotton. When a mixing is used, the cotton should be pulled away in small sections from the top to the bottom of the mixing so as to obtain portions of each bale.

It is a good plan when using bales of different marks, to average the mixing so that no two bales of the same mark shall come in contact with each other. The following rule is used to find the number of sections that should be made in order to obtain the correct proportion of each mark in a section.

14. Rule.—*To find the number of sections of which a mixing should consist, find the largest number that will exactly divide the number of bales of each mark. Then, to find the number of bales of each mark that there should be in each section, divide the number of bales of each mark by the number of sections in the mixing.*

EXAMPLE.—Find a suitable order for mixing 100 bales, the mixing to consist of 40 bales marked A B C; 20, G H I; 10, J K L; and 30, D E F.

SOLUTION.— 10 is the largest number that will exactly divide 40, 20, 10, and 30; therefore, the mixing should be made up of 10 sections, and in order to prevent any two bales of the same mark coming in contact with each other, they could be arranged as follows:

$$\left.\begin{array}{c}\text{G H I}\\ \text{D E F}\\ \text{A B C}\\ \text{J K L}\\ \text{D E F}\\ \text{A B C}\\ \text{G H I}\\ \text{A B C}\\ \text{D E F}\\ \text{A B C}\end{array}\right\}\text{10 times. Ans.}$$

15. It is the practice in some mills to go over the covers of the bales after the cotton has been removed and pick off the loose pieces of cotton adhering to them. This is a practice that should only be encouraged to a small degree, as the amount of cotton obtained is hardly sufficient to pay for the time occupied in its removal, and there is also a liability of jute fibers from the burlap becoming mixed with the cotton and causing poor work in the subsequent processes.

16. Mixing Different Varieties of Cotton.—The subject as it has been treated refers only to mixings where the cotton of different marks is all approximately of the same grade. Where it is desired to blend cotton of different varieties for special purposes, it is not necessary that it should be done in the mixing. For example, where it is desired to mix exact proportions of different varieties, as American with Egyptian, or where dyed stock of one color, or more, is to be blended with white, the cotton may be blended to better advantage at some of the subsequent processes.

Different growths of cotton are sometimes mixed together for special purposes. Thus, American cotton is mixed with Egyptian in order to cheapen the mixture, Egyptian cotton usually being higher priced than American. By this means a yarn is produced that practically has the qualities of a pure Egyptian yarn; and yet the cost is less than that of pure Egyptian. Brazilian cotton is sometimes mixed with American in order to increase the strength of the yarn, as Brazilian has a strong, wiry staple; while rough Peruvian cotton is mixed with Egyptian in order to give the latter woolly qualities, the Peruvian being of a harsh, crisp nature.

Although cotton is often mixed in this way, it must be understood that there is a certain limit to the mixing of harsh and soft cottons, as they do not give the same results under the same treatment in the subsequent processes; nor is it practical to mix long- and short-stapled cotton, as the machines of the later processes are set according to the length of the staple, and if set for one length of staple will either damage cotton of a different length or cause an imperfect product.

BALE BREAKER

17. Description.—A machine known as a **bale breaker** is sometimes used in mixing cotton. Its object is to separate the matted masses of cotton as they come from the bale and to deliver the cotton in an open state to the mixing bins. This machine, consequently, does the work that is performed by hand in hand mixings. When using a bale breaker for mixing cotton, a good method is to have about six bales open around the feed-end of the machine and to take a layer of cotton in rotation from the top of each bale. The principle employed to attain the object of the bale breaker is to have three or four pair of rolls, each pair revolving at a higher rate of speed than the preceding pair. The cotton fed to the pair that is revolving at a slow speed, is pulled apart when it comes under the action of the pair revolving at a faster speed. Fig. 1 shows a view of a bale breaker with conveying aprons attached, while Fig. 2 gives an illustration of the different sets of rolls that act on the cotton and constitute the principal mechanism of this machine. Referring to these two figures, the cotton is taken from the bales and placed on the horizontal apron *a*, which is moving in the direction shown by the arrow. As the cotton reaches the first set of rolls, it is gripped and carried forwards to the next set, each pair of rolls having a greater circumferential velocity than the preceding pair, the circumferential velocity of the second pair being about twice that of the first pair, while the circumferential velocity of the third pair is about four times that of the second, and the last pair about five times that of the third. The first set of rolls usually makes between 5 and 6 revolutions per minute.

The space between the different sets of rolls will be found to vary with different makes, but usually from the center of one pair to the center of the next is about 9 inches. The upper roll of each set rotates in bearings having a vertical movement, but held down by means of strong springs *b* connected with the upper rolls by means of the rods *c*. By this means the upper rolls are allowed to give when an

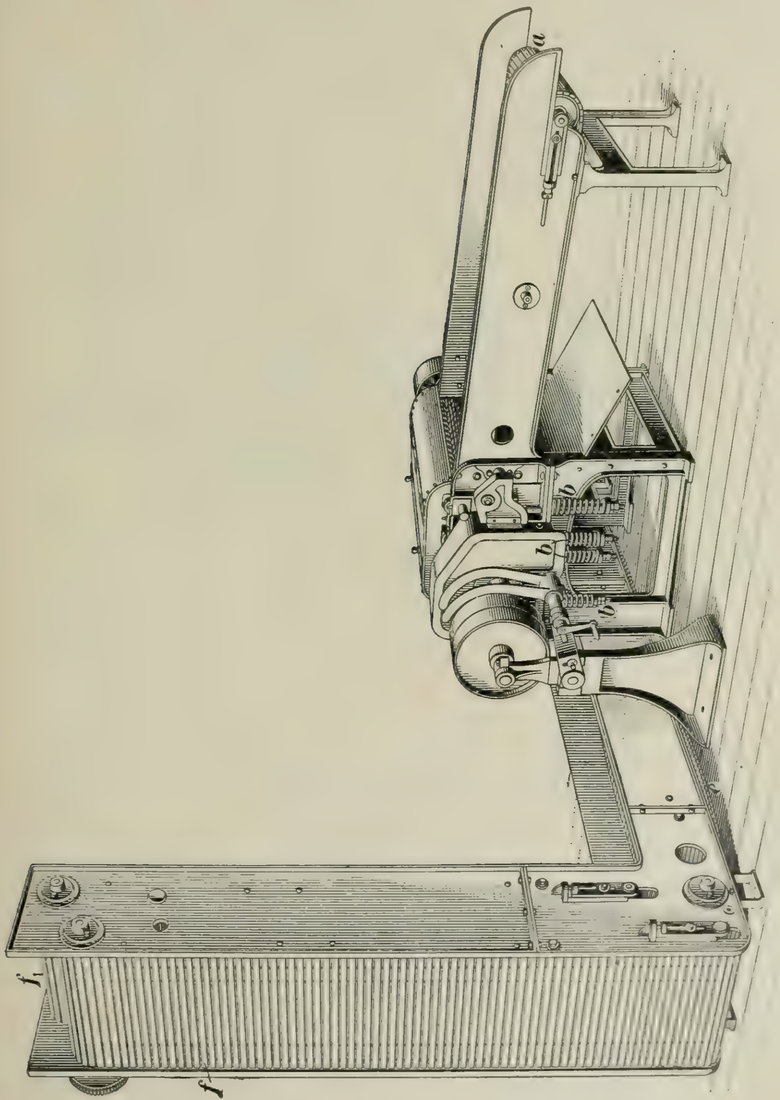


FIG. 1

excess of cotton passes between the rolls. In the bale breaker shown in these illustrations, the pair of rolls farthest from the feed-end of the machine is the largest, being nearly 9 inches in outside diameter, while all the other rolls are $7\frac{1}{4}$ inches in outside diameter. These rolls will be found to vary in construction, in some cases being solid with flutes their whole length, while in other cases they are made up of rings having projecting spikes and placed side by side on a core in such a manner that when a spike breaks it is simply necessary to replace the ring containing the broken spike.

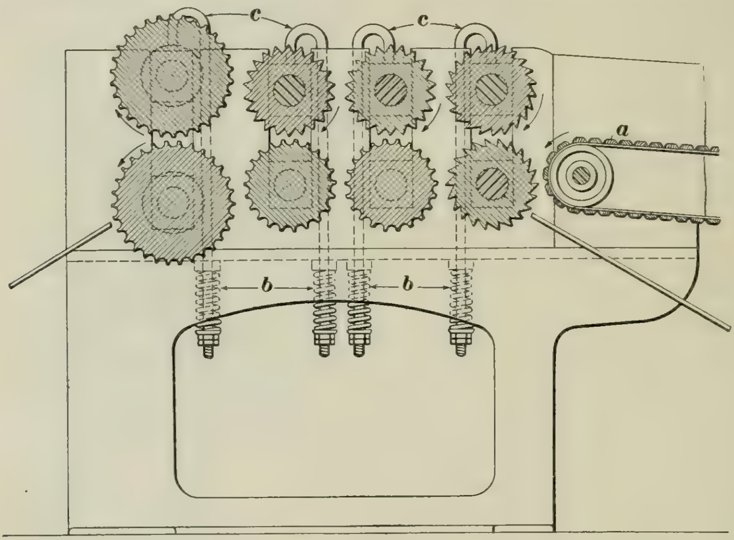


FIG. 2

A somewhat different arrangement of the rolls is shown in Fig. 3, in which a series of nosed levers *d* are made to take the place of the lower roll of the first set.

The cotton as it leaves the last set of rolls drops to the lower apron *e*, Fig. 1, which conveys it to the lifting aprons f, f_1. These lifting aprons have their inner surfaces moving in the same direction and sufficiently close together to prevent the cotton dropping down. The aprons are built of wooden laths, with rounded edges, fastened to endless leather belts. It is customary to construct the elevating

aprons with laths at intervals that project higher than the rest, and thus convey the cotton more positively than if all are of the same thickness. From these elevating aprons the cotton is delivered to horizontal aprons, which carry the stock to the different mixing bins.

18. Care of Bale Breakers.—There are several points that should receive attention in the care of bale breakers. The cotton should not be fed in too thick layers, since this

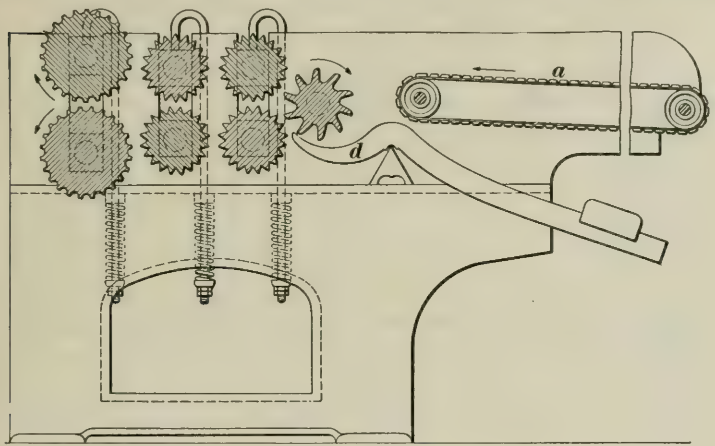


FIG. 3

is liable to strain the rolls; all the dirt from underneath the machine, which consists chiefly of sand and other foreign substances that drop from the cotton as it is pulled apart, should be removed periodically; and what is more important, the machine should be properly oiled. The aprons should also be adjusted so that they will not come in contact with each other at any point.

PICKER ROOMS

19. The room containing the machinery through which the cotton passes during its first stages of manufacture is known as the **picker room,** and its equipment for medium counts generally consists of an automatic feeder, opener, breaker picker, intermediate picker, and finisher picker.

Where the bale breaker is used, that, also, may be found in this room, although it is usually in the mixing room. Other machines, in some cases, may also be found in this room, such as waste openers and waste breakers. In mills using long-stapled cotton and producing fine yarns, either the intermediate or the intermediate and finisher pickers would be omitted from the above list in order to lessen the beating action.

20. Location of Picker Rooms.—The picker room is sometimes located in a building some distance from the main mill, but if it is a part of the main building, it should be separated by a fireproof partition or wall. The machinery located in this room being a heavy type of cotton-mill machinery and running at a very high rate of speed, also dealing with stock in a very unclean condition, necessitates these precautions, since, if the swiftly moving parts of the machinery come in contact with any foreign matter of a hard nature, a fire will in almost every case occur and spread throughout the cotton. Fires occur more frequently in the earlier processes of the manipulation of the raw stock than at any other time. Therefore, the planning of the rooms and the arrangement of the machinery in them must be given very careful attention.

ARRANGEMENT OF MACHINES

21. In large mills, usually two rooms at least are devoted to the mixing and picking, the mixing, feeding, and opening being generally carried on in one room, while the breaker, intermediate, and finisher pickers are located in another room. Fig. 4 shows such an arrangement. With the machines arranged as shown in this figure, the cotton will be opened on the first floor and then fed to the automatic feeder *a*, passing from this to the opener *b* and then by trunking *c* to the breaker picker *d*, which is located on the second floor. From the breaker picker, the cotton passes to the intermediate picker *e*, while the finisher picker *f* takes the cotton from the intermediate. In case a bale breaker were used with this arrangement, it would be situated in the

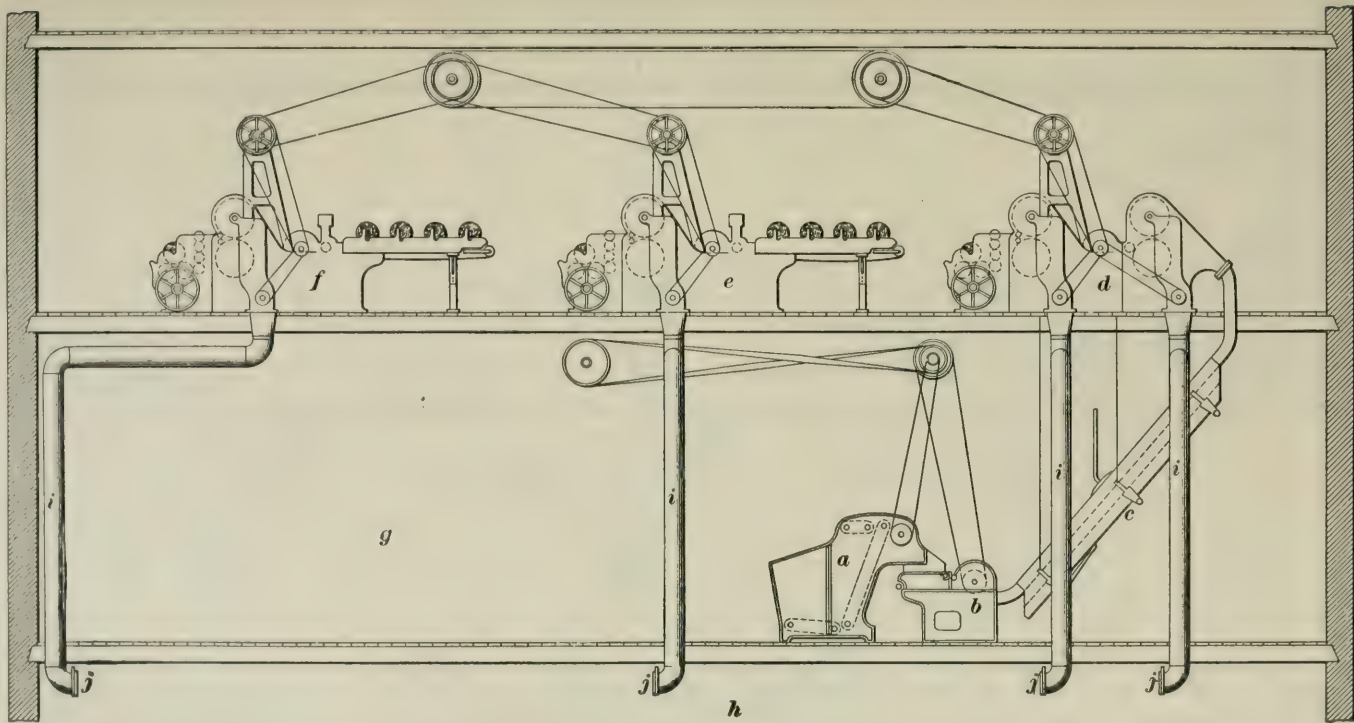


FIG. 4

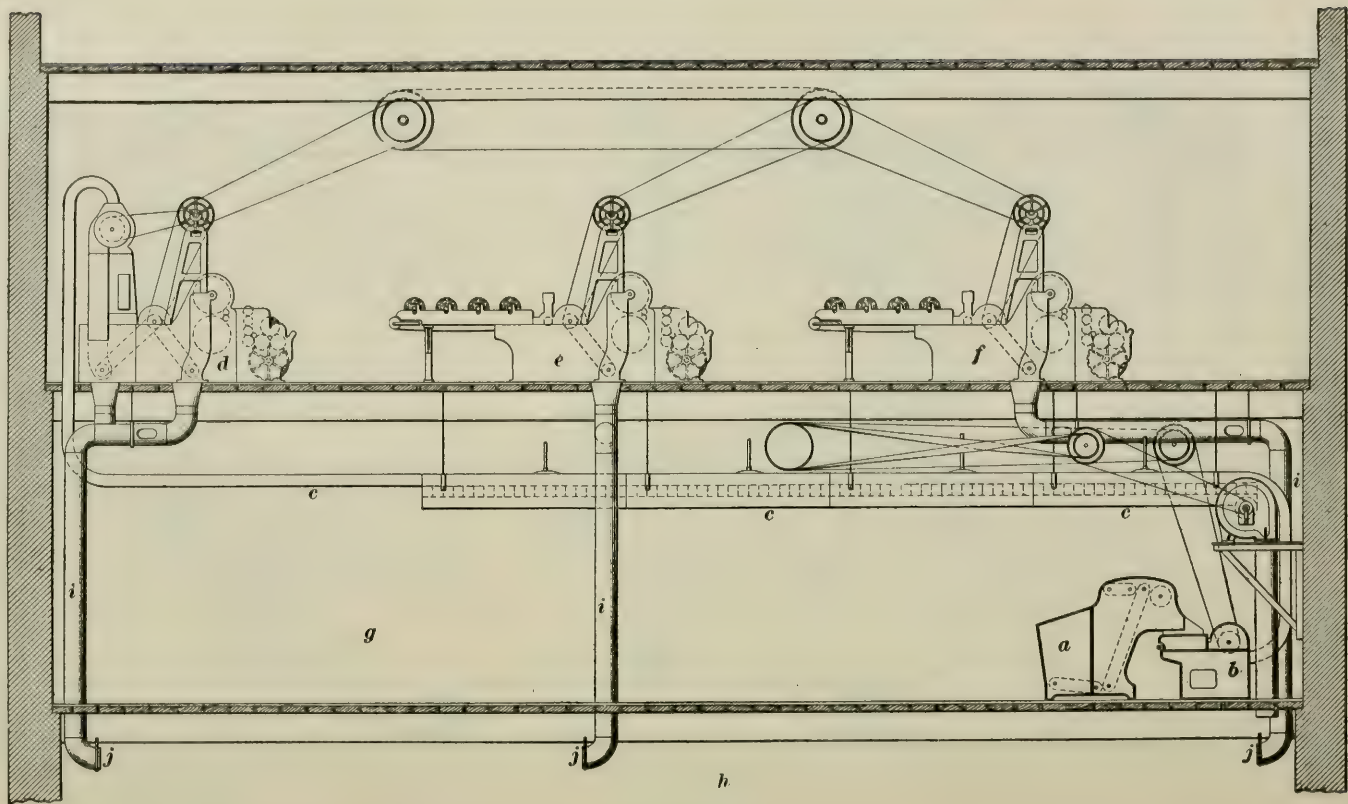


Fig. 5

opening room *g* and aprons would be so arranged that the cotton would be carried from the bale breaker to mixing bins situated in such a position behind the automatic feeders that the cotton could be conveniently handled.

22. Fig. 5 shows a very similar arrangement to that shown in Fig. 4. In this figure, however, a different method of connecting the breaker picker and opener is adopted. The feeder is shown at *a* and the opener at *b*. From the opener the cotton is conveyed to the breaker picker *d* by means of a horizontal trunk *c*. The intermediate picker *e* takes the cotton from the breaker, and the finisher picker *f* takes it from the intermediate.

Many different arrangements of these machines will be found in mills. In some cases, the bale breaker, together with the automatic feeder and opener, is located on the second floor and connected by trunking with the pickers, which are on the first floor. In other cases, all the machines are in one room. In Figs. 4 and 5, a dust room *h* is shown under the opening room *g*. This is usually constructed in the basement, and to it are conducted the dust trunks *i*. The ends of these trunks are usually provided with automatic closing dampers *j*, which remain closed when the machine from which the dirt comes is not in operation. By this means, a draft in the trunks is prevented in case of fire, and any back draft that would cause dust and particles of dirt to reenter the cotton is also avoided.

FEEDING AND OPENING

AUTOMATIC FEEDER

23. Principle.—The **automatic feeder** is the first machine that receives the cotton after it has been mixed, and, as its name indicates, is used for the purpose of automatically supplying or feeding another machine.

Formerly, the opener or breaker picker was fed by one of three methods: (1) by spreading the cotton on a feed-apron by hand, the amount depending on the judgment of the

operator; (2) by weighing a certain amount of cotton and spreading it by hand on a measured space on a feed-apron; (3) by presenting a portion of cotton to an opening in a pneumatic tube and allowing it to be drawn in by the air-current. With these methods it was very difficult to obtain a uniform feed.

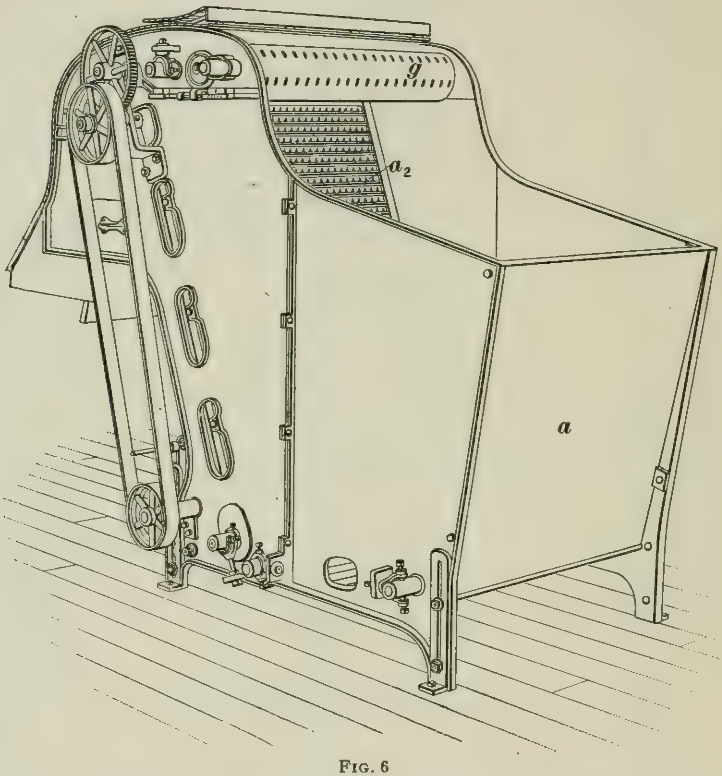


FIG. 6

The principle employed in the automatic feeder is that of having an apron with projecting spikes carry away from a mass of cotton a larger quantity than is required, the excessive amount being removed by suitable mechanism and only that portion which is required being allowed to pass forwards to supply the next machine. Fig. 6 is a perspective view of the automatic feeder, while Fig. 7 shows a section. The

cotton is fed by the operator to the hopper *a*, which should be kept at least half full. The bottom apron a_1 tends to carry the whole mass toward the lifting apron a_2, the cotton being retarded slightly by friction with the sides of the hopper. The spikes in the lifting apron fill with fiber from the base to the point, and often retain comparatively large bunches of stock. After filling, they continue to move upwards, and the tendency for so large a number of points

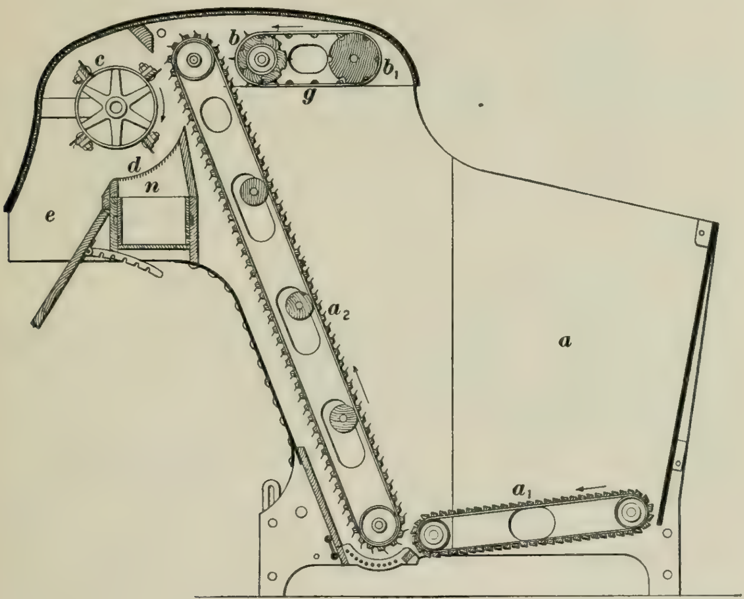


FIG. 7

acting on the mass of cotton is to impart a rolling motion to it. The stripping roll *b* acts continuously on the cotton carried by the lifting apron as it arrives at the point nearest to the stripping roll. The surface of this roll, moving in the opposite direction from the lifting apron and only about 1 inch from the point of the spikes, strikes off the excess cotton.

The cotton remaining on the lifting apron is the amount necessary to supply the machine to which the feeder is attached, and must be removed from the pins carrying it.

This is done by the doffer beater *c*, the surface of which moves in the same direction as the part of the apron nearest to it, but at a greater speed. The fibers removed from the lifting apron are in small tufts, and a certain quantity of sand, etc. is thrown out by the centrifugal force of the doffer beater or drops by its own weight. This passes through the bars of the grating *d* into the chamber *n*. The cotton passes forwards and through the passage *e*.

A feeder is sometimes used to take the place of the bale breaker previously described. This feeder is constructed on practically the same lines as the one illustrated here, although the parts are made much heavier in order to withstand the greater strain that is brought on them on account of dealing with stock directly from the bale. In some mills running fine counts, the bale breaker is dispensed with and two automatic feeders used, the cotton as it comes from one being fed into the other. In such cases the cotton, of course, must be opened and mixed to a certain extent by hand.

24. Lifting Apron.—The lifting apron of the automatic feeder as generally constructed consists of an endless canvas sheet mounted on leather belts, to which it is fastened by copper rivets. On this canvas sheet wooden laths are fastened $1\frac{1}{2}$ inches apart. Set in the laths about 1 inch apart are steel spikes that project from the laths about 1 inch. It is these spikes of the lifting apron that convey the cotton to the point desired as it is presented to them by the feed-apron.

25. Stripping Device.—Fig. 8 (*a*) and (*b*) shows detail views of the stripping device found on the feeder shown in Fig. 6. It consists of two rolls b, b_1 of wood mounted on an iron core. An endless leather apron *g* passes around the rolls; on the inside of the apron are secured strips of wood that engage with grooves in the rolls, so that the apron *g* and roll b_1 are positively driven by *b*. These rolls are not exactly alike in every respect, as the one nearer the lifting apron carries pins that project through elongated holes in the apron, as shown in this figure. At the point *h* the pins strike the excess cotton from the lifting apron back into the hopper,

while that which adheres to the pins is removed as the roll revolves and the pins are drawn through the apron. In (*b*) are shown the adjustments provided for regulating the distance from the pins of the stripper comb to the lifting apron, and thus regulating the amount of excess cotton removed; the adjustment for regulating the tension of the apron is also shown. In order to regulate the distance between the roll *b* and the lifting apron, the casting that supports the bearings

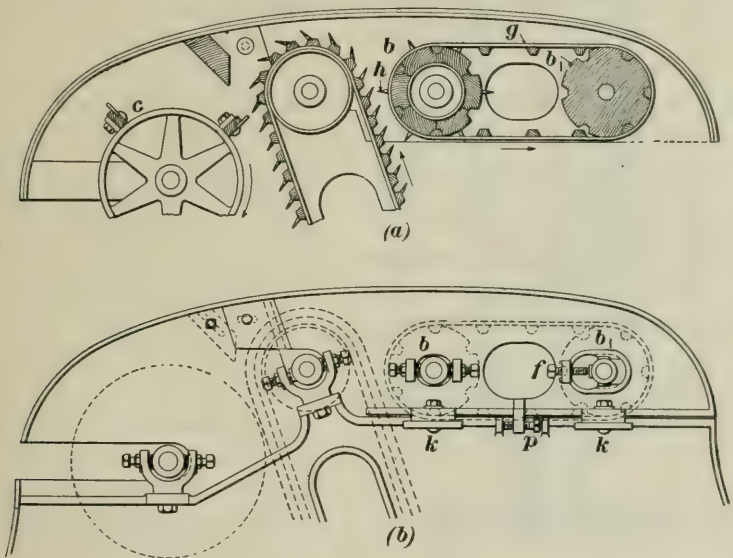
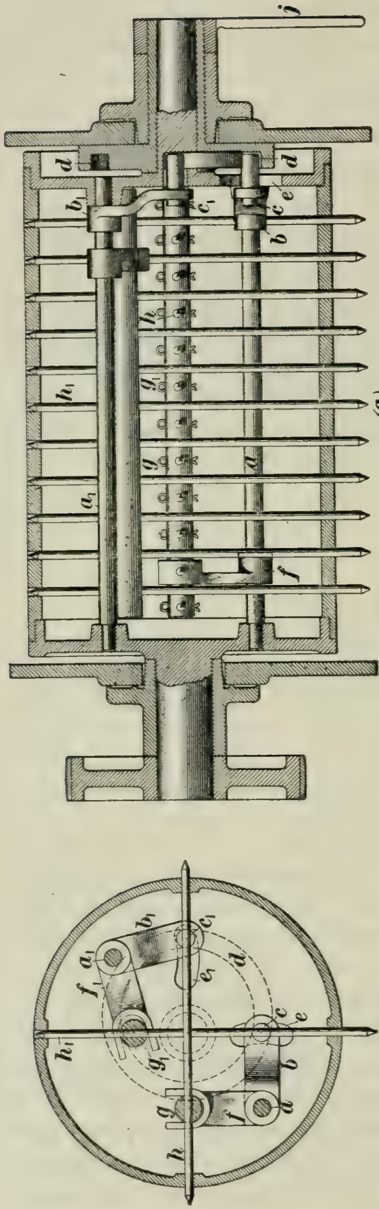


FIG. 8

of this roll is made so that it may be moved on the framework by loosening the bolts at *k* and turning the screw *p*. The tension of the stripping apron is regulated by the screw *f*, which holds the bearing of the roll b_1 in position.

A stripping device that differs in construction from that shown in Fig. 8 is shown in the two sectional views, Fig. 9 (*a*) and (*b*). It consists of a metal shell that contains two shafts a, a_1, which have bearings in the circular ends of the shell and are capable of being moved in these bearings. These shafts carry castings b, b_1, known as *trailing levers*. On the end of each trailing lever are studs c, c_1 that work



(a)

(b)

FIG. 9

in a cam-course d. The cam is on the outside of the shell, while the trailing levers are on the inside; slots e, e_1 are provided in the end of the shell for the studs to project through, and also in order that they may have a certain freedom of movement.

Supported from the shafts a, a_1 by means of the brackets f, f_1, of which there are several in the length of the shell, are the shafts g, g_1. Each of these shafts carries a series of pointed rods h, h_1 that project through the surface of the shell. As the shell revolves and the cam remains stationary, an oscillating motion is imparted to the shafts a, a_1; motion is also given to the shafts g, g_1, which results in one end of the pointed rods projecting from the shell during a part of its revolution, while at other times they are within the shell.

In Fig. 9 (a) is shown a handle j by means of which the position of the cam may be regulated. If it is desired to feed more cotton, the position of the cam is changed so that

the points will not project so far at the point where they are nearest the lifting apron. If it is desired to feed less cotton, the position of the cam is so changed that the points will project farther from the shell when nearest the lifting apron and thus strike off more cotton. The cam, after being placed in the correct position, is secured by a setscrew.

In Fig. 9 (*b*) it will be seen that when one end of a pointed rod is projecting, the other end has been withdrawn into the shell. By this means, any cotton adhering to the rod is removed and falls back into the hopper.

26. Doffer Beater.—The doffer beater differs in construction in different makes of machines. In some cases it consists of a cylinder carrying four rows of teeth that project about $2\frac{3}{4}$ inches from the cylinder, each row containing as many teeth as there are teeth in one row on a slat of the lifting apron. Such a doffer is so placed that one of its teeth will project between two of the teeth of the lifting apron and be just half way between them. By this means, as the doffer revolves, it removes the cotton from the lifting apron and drives it downwards through the passage provided. In other cases the doffer, instead of having spikes to remove the cotton from the lifting apron, has strips of heavy leather projecting about 2 inches and secured to horizontal pieces of wood mounted on a central shaft, while in still other cases the doffer beater is constructed in such a manner that rows of spikes will alternate with strips of leather.

Fig. 10 shows a perspective view of an automatic feeder combined with an opener, while Fig. 11 shows a sectional view of a similar arrangement. The feeder shown in these illustrations differs from that previously described principally in regard to the manner in which it regulates the amount of cotton fed. By referring to these figures it will be noticed that the lifting apron is driven by a pair of cones, the ends of which are shown in Fig. 11. The belt guide that regulates the position of the belt on the cones is shown at *g*. By turning the hand wheel *l*, Fig. 10, the belt is moved on the cones and the speed of the lifting apron regulated as may be

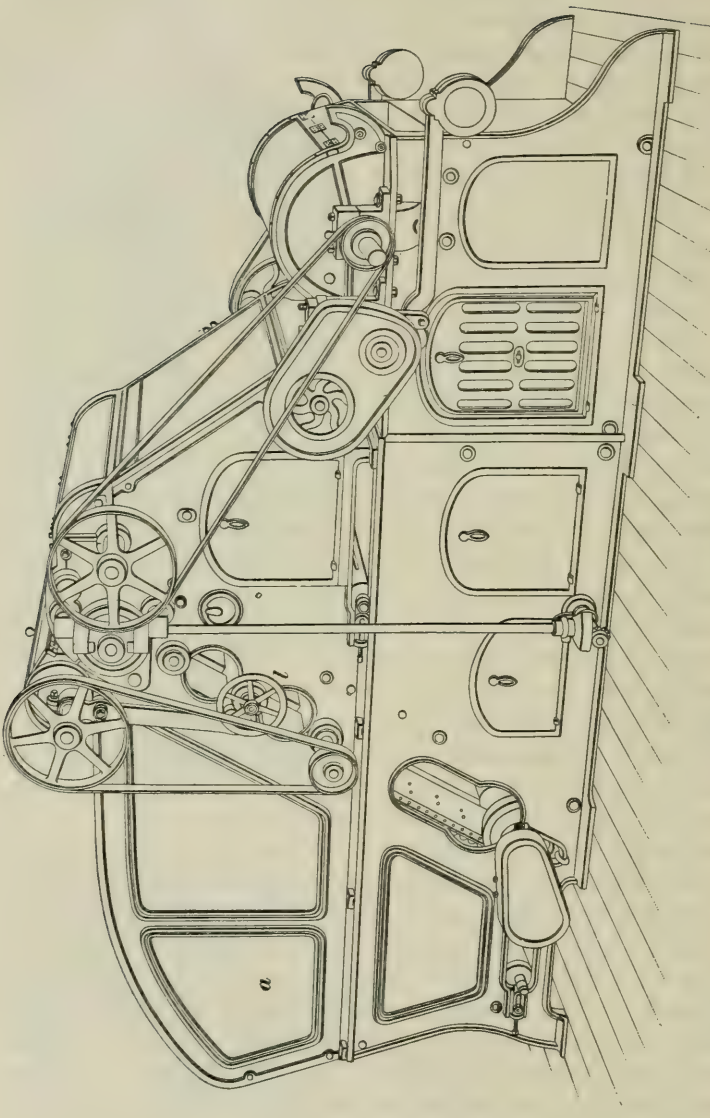


FIG. 10

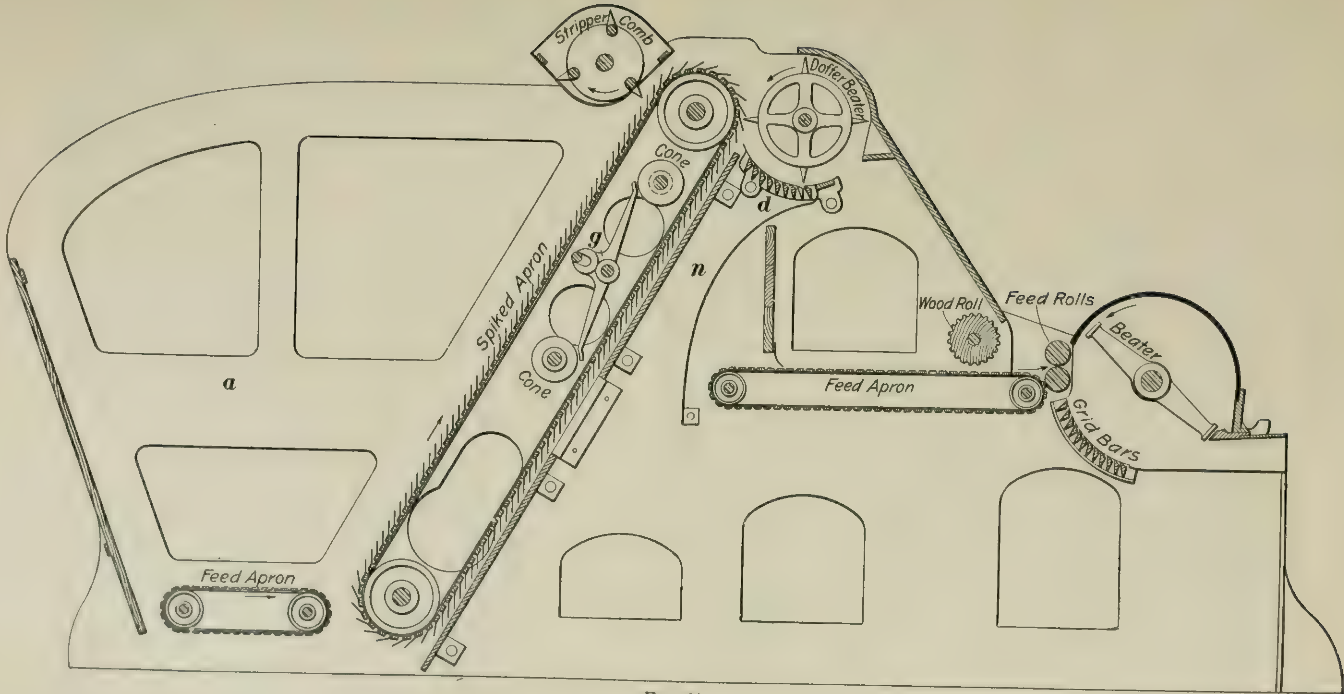

Stripper Comb
Doffer Beater
Cone
Cone
Spiked Apron
g
d
n
a
Wood Roll
Feed Rolls
Beater
Feed Apron
Grid Bars
Feed Apron

Fig. 11

desired. The connection between the cones and the lifting apron is described later. This method of regulating the feed is frequently resorted to, as it affords a ready means of making the necessary change. It will be seen that, if the stripping roll should be moved too far from the lifting apron, the cotton would be liable to be fed in lumps and thus would not be sufficiently opened. On this account it has been found to be advisable, in ordinary cases, to increase the speed of the lifting apron when it is desired to feed more cotton, and for this reason most feeders, as now built, have some method by which the speed of the lifting apron may be regulated, either by the cone drive, as illustrated above, or by change pulleys, change gears, or step cones. The regulation of the speed of the lifting apron, as well as the position of the stripping roll to give a required weight of cotton fed, is a matter of experiment and observation and depends entirely on the stock used.

The passage provided in this machine for the dirt that is struck from the cotton by the doffer beater consists of a grid *d* made of metal bars set with a slight space between them.

27. Gearing.—The gearing of the automatic feeder shown in Figs. 10 and 11 is as follows: The doffer beater is driven from the countershaft or main shaft of the machine that the feeder supplies and runs at a speed of from 400 to 500 revolutions per minute. On the shaft of the doffer beater is a 6-inch pulley that drives a 16-inch pulley on the bottom cone. The two cones are 6 inches in diameter at their larger ends and 3 inches in diameter at their smaller ends. On the shaft of the top cone, a gear of 16 teeth drives a gear of 69 teeth on a shaft that extends across the feeder. A gear of 17 teeth on this shaft drives a clutch gear of 58 teeth on the top carrier roll of the lifting apron. This top carrier roll is 9 inches in diameter. The feed-apron is driven from the bottom bearing shaft of the lifting apron, on which there is a sprocket gear of 18 teeth, which drives, by means of a chain, a sprocket gear of 28 teeth on a roll supporting the feed-apron. This roll is 3 inches in diameter. The wooden roll, feed-apron and feed-rolls of the opener shown in these

illustrations are driven by means of a chain and sprocket gears from the shaft of the top carrier roll of the lifting apron.

28. Capacity.—The capacity of automatic feeders is very great, but since the amount of work they do is governed entirely by the requirements of the machine they feed, they are rarely run at their full capacity. Usually about 3,000 pounds in 10 hours is the maximum amount run through a feeder.

29. Care of Feeders.—In order that feeders may perform their best work, they should be kept well oiled. The dirt should be removed periodically; the aprons should be kept taut by the tension screws provided for this purpose; and the hopper should be kept at least half full, since the less cotton there is in the hopper, the greater is the liability of the lifting apron securing an insufficient amount, thus causing the weight to vary. It is customary for one man to attend to about ten feeders in large mills. In smaller mills the work of feeding is combined with other duties.

The feeder requires from $1\frac{1}{2}$ to 2 horsepower, and occupies a floor space of about 6 feet 4 inches by 6 feet 6 inches.

OPENER

30. The **opener** is not used in all mills, as the automatic feeder is sometimes connected directly to the breaker picker, but in mills where this machine is used it generally forms a combination machine with the automatic feeder, as shown in Fig. 10. Technically, the automatic feeder ends with the doffer beater, or, as it is sometimes called, the *pin beater*, Fig. 11.

The opener has for its objects the cleaning of the heavy impurities from the cotton and the separating of the cotton into small tufts that are light enough in weight to be influenced by an air-current generated by a fan in the succeeding machine. It attains these objects by presenting a fringe of cotton to a beater that makes from 1,200 to 1,800 revolutions per minute. This beater usually has two blades, and consequently for every revolution delivers two blows to the

fringe of cotton. By this means any foreign substance will be struck from the fringe of cotton as it is held by the feed-rolls, and knocked through the grid bars shown in Fig. 11. The tufts of cotton will also be removed from the fringe as soon as they are released from the bite of the feed-rolls, and thus they will be sufficiently light to be acted on by the air-current that conveys the cotton to the next machine.

The cotton after being acted on by the doffer beater of the automatic feeder falls on a feed-apron, and being separated into small tufts, occupies so much space that the wooden roll and feed-rolls, shown in Fig. 11. are used to condense its bulk before being presented to the beater of the opener.

The opener alone occupies a floor space of about 5 feet by 6 feet 6 inches, and when connected with a feeder occupies a space of 11 feet 4 inches by 6 feet 6 inches. It requires about 3 horsepower to drive it. Openers are rarely run at their full capacity, the amount of cotton they are made to deliver depending on the amount required to supply the breaker picker.

TRUNKING

31. The cotton from the opener is carried along a **trunk** to the next machine by means of an air-current that is generated by a fan. This fan exhausts the air in the trunk, and thus the air in the room containing the feeder enters through the openings between the grate bars in the opener, and carries the cotton with it as it passes through the trunk to the fan.

The various forms of trunks are as follows: (1) *plain conducting trunks*, (2) *horizontal cleaning trunks*, (3) *inclined cleaning trunks*.

32. A **plain conducting trunk** consists of a circular tube of sheet metal from 10 to 13 inches in diameter. It should have easy curves wherever the tube bends, and should contain sufficient doors for cleaning purposes. The inner surface should be smooth, so as to cause as little friction as possible in the transit of the cotton. These trunks are used simply to conduct cotton from one point to another.

Horizontal cleaning trunks are constructed of wood and contain doors for the removal of the dirt, also grids

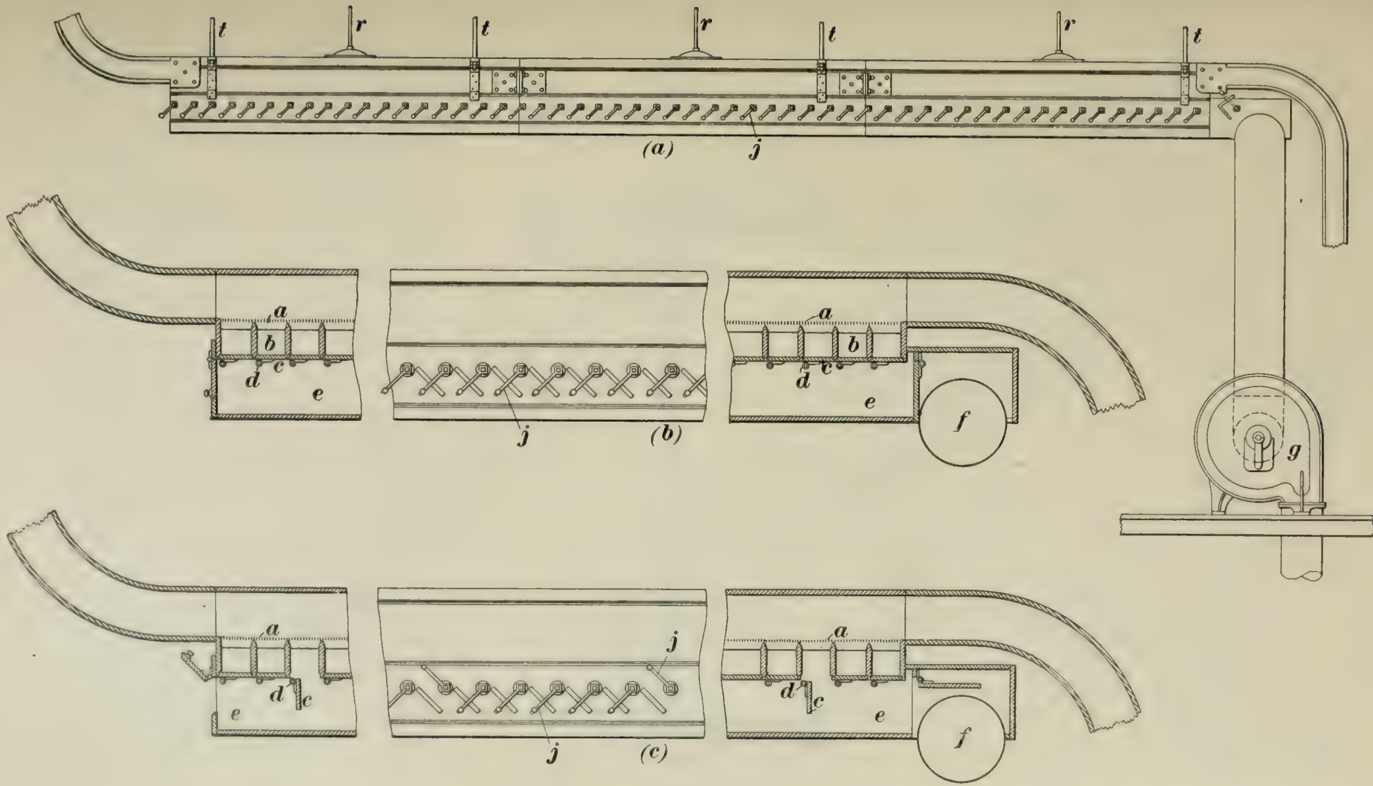


FIG. 12

through which the dirt falls. They may be built either shallow and wide, or narrow and deep.

Inclined cleaning trunks are of the same construction as horizontal cleaning trunks, but have an inclined position.

33. Fig. 12 (*a*), (*b*), and (*c*) shows a horizontal cleaning trunk supported by rods *t* placed about 10 feet apart on each side of the trunk. In the center of the trunk are connections for sprinklers *r*. A section of this trunk is shown in Fig. 12 (*b*). The upper part is a clear passage, along which the cotton is carried over a grating *a*. During this passage of the cotton, any foreign matter that is too heavy to be carried along with the cotton by the force of the air-current, will drop through the grating *a* into the pockets *b*.

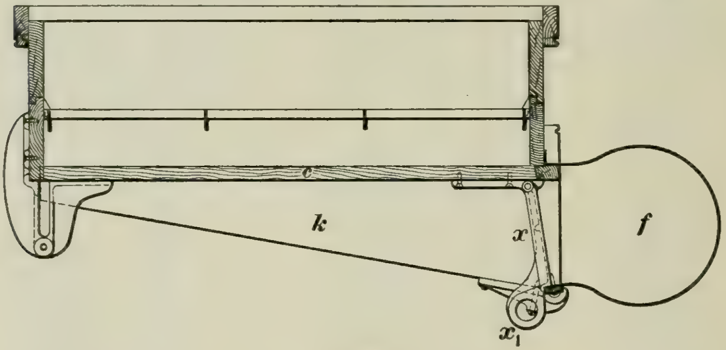


FIG. 13

The portion of the trunk containing the grating is called a cleaning trunk and does not extend the entire length of the trunk, the remainder being simply a conducting trunk. Forming the bottom of each pocket *b* are doors *c* hinged at *d*, below which is another passage *e*, which has a door at each end. Connecting with this passage *e* is a trunk *f*, which extends to the dust room and contains a fan *g*.

When it is desired to remove the dirt that has fallen through the grating, the breaker picker is first stopped; the springs that hold the doors are released; and the doors fall, delivering the dirt into the passage *e*. The doors *c* are then closed by means of the handles *j*, and the doors at each

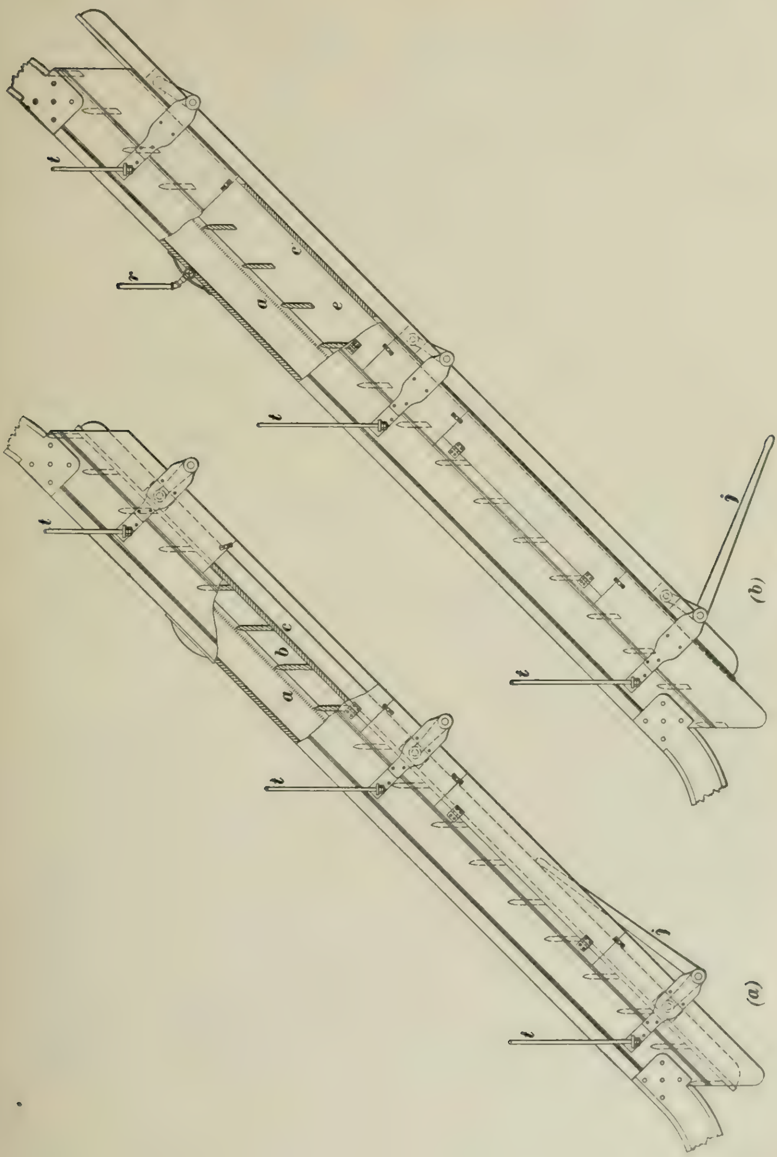


FIG. 14

end of the passage *e* opened. The fan *g* creates a current of air in the passage *e*, which carries the dirt to the dust room. The positions that the doors assume at various times during this process are shown in Fig. 12 (*c*).

If the breaker picker were not stopped during this process, the air-current of this machine would tend to draw the dirt back into the cotton when the doors *c* were opened. The air-current of the breaker picker would also act against the air-current of the fan *g* if both were running.

34. Another style of horizontal trunk is shown in Fig. 13. The passage for the cotton and the grating are constructed on the same principles as those just described; but the trunk *f* for removing the dirt, instead of being at the end, extends along the side of the main trunk. When it is desired to remove the dirt, the doors *c*, which are made of wood and supported by the latch *x*, are dropped by pulling the ring x_1, thus causing the latch to be pulled off its support. This forms an incline down which the dirt slides into the trunk *f*. In order to prevent the dirt from falling off the sides of the door *c* when it is lowered, there are boards *k* that form sides as the door *c* drops between them.

35. One style of an inclined cleaning trunk is shown in Fig. 14 (*a*) and (*b*). This trunk contains the usual grating *a*, over which the cotton passes, while the dirt and other foreign substances fall through this grating into the pockets *b*. The bottom of these pockets is formed by *c*, which is capable of being raised or lowered by the lever *j*. The position that the bottom ordinarily occupies is shown in Fig. 14 (*a*); when, however, it is desired to remove the dirt from the pockets *b*, the lever *j* is brought into the position shown in Fig. 14 (*b*). In this case the bottom *c* is lowered into the position shown, causing the dirt from the different pockets to fall out into the chamber *e* and slide, by its own weight, down the incline into the dust chamber.

PICKERS

(PART 2)

COTTON PICKERS

BREAKER PICKERS

METHODS OF FEEDING

1. The **breaker picker** is the first machine that deals with the cotton after it leaves the opener. This machine may receive the cotton either directly from an automatic feeder, or from an opener through a trunk; in the latter case, the cotton first comes in contact with either a *condenser* and *gauge box* or a *cage section.* When the breaker picker is fed directly from an automatic feeder, the cotton is generally dropped on an apron, from which it is taken by the feed-rolls of the picker.

2. The Condenser and Gauge Box.—The manner of feeding the picker by means of a **condenser** and **gauge box,** when the cotton is conveyed through a trunk from the opener, is shown in Fig. 1. The air-current that draws the cotton from the opener through the trunk *a* is generated by a fan *b*. After leaving the trunk, the cotton first comes in contact with a cylinder of wire netting known as a *cage,* shown at *c*. About two-thirds of the inner circumference of this cage is protected by a cradle *d* of sheet metal, which prevents the cotton from being drawn to this protected part

of the cage, the air-current passing out through the ends of the cage and down the passage b_1. The cradle d remains stationary, but the cage c revolves in the direction shown by the arrow, and thus the cotton, which is drawn to that part of the cage that is not protected by the cradle, is brought around until it comes under the action of the stripping rolls f, g, which remove it from the cage. The roll f is held

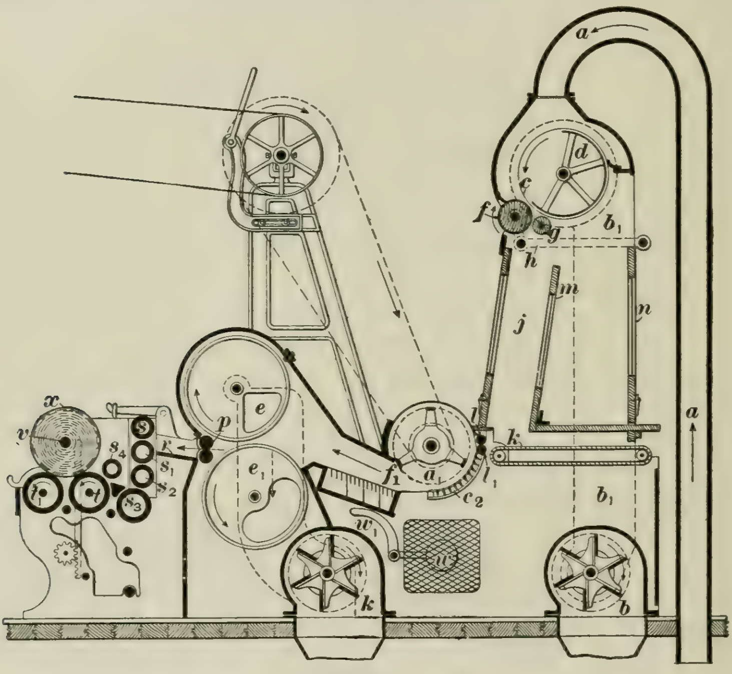


FIG. 1

in position in pivoted bearings by the lever h, so that it will be as close to the cage as the bulk of cotton passing will permit. The cotton then drops into the gauge box j and on to the apron k, from which it is removed by the feed-rolls l, l_1, of the breaker picker.

The condenser is usually understood to consist of the upper part of the arrangement shown in Fig. 1, including the parts marked c, d, f, g, and h.

3. The cotton that passes through the picker is wound in the form of a sheet on a lap roll *v*, shown at the front of the machine in Fig. 1, the lap that the cotton forms being marked *x*. When the lap is removed, the feeder that supplies this machine is usually stopped and also all parts of the breaker picker except the beaters, fans, and revolving parts of the condenser. Since the fans continue to run during this

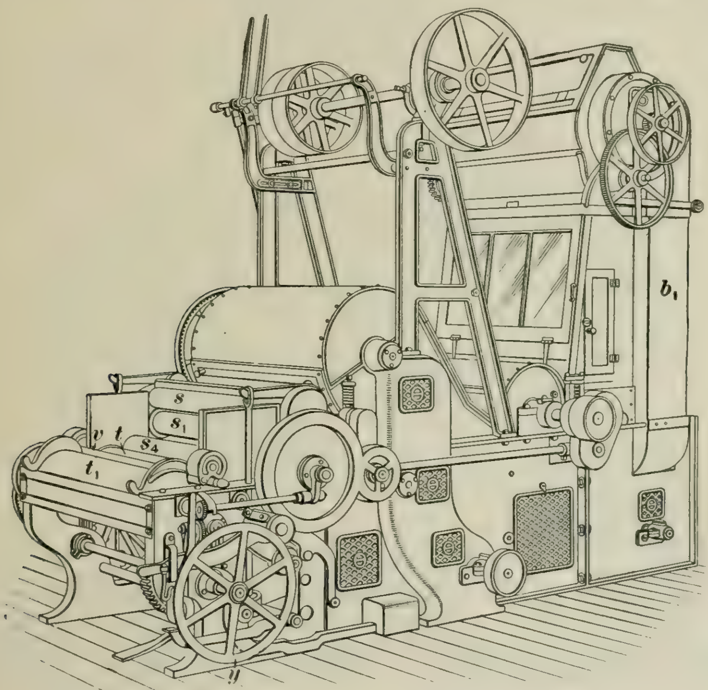


FIG. 2

period, the cotton that is in the trunk *a* will be delivered to the picker. It is the object of the condenser and gauge box to take care of this stock and thus prevent the passage from becoming blocked by the cotton coming from the trunk. With the arrangement shown in Fig. 1, the cotton collects, while the picker is stopped, in the gauge box *j* until it is completely filled, when any more cotton coming from the

trunking will fall over the top of the partition *m*; it can then be removed by means of the door *n* and returned to the mixing. When the picker and feeder are restarted, the amount of cotton that is in the gauge box *j* will supply the feed-rolls l, l_1 of the picker until sufficient cotton is coming through the trunk *a*.

Fig. 2 is a perspective view of a picker with a condenser and gauge box.

4. Cage Section.—A sectional view of a breaker picker that receives the cotton by means of a cage, or screen, section

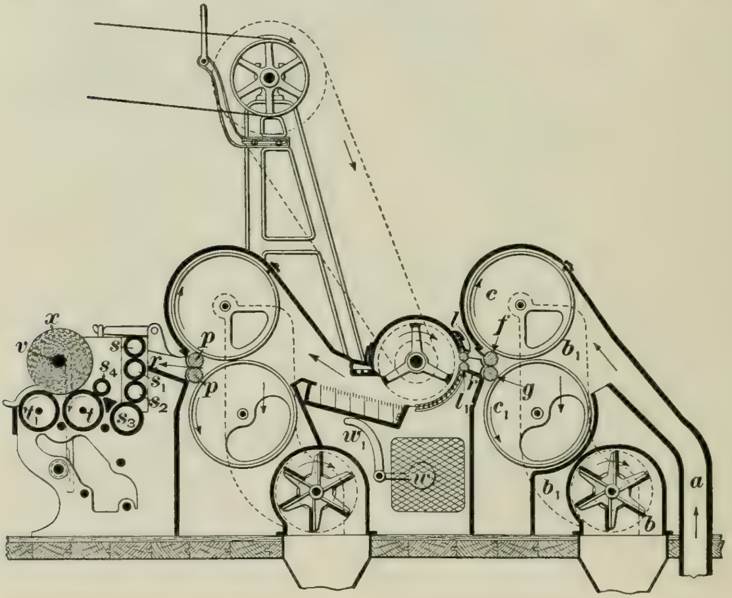


FIG. 3

is shown in Fig. 3, while Fig. 4 is a perspective view. An air-current generated by a fan *b* draws the cotton from an opener through a trunk *a* to two cages, or screens, c, c_1. These cages are protected so that as the air-current passes out through their ends, down the flue b_1 to the dust room, the cotton is drawn to the portions of their circumferences nearest the delivery end of the trunk *a* and, as the cages

revolve in the direction shown by the arrows, is condensed in a sheet between them; it is removed by the stripping

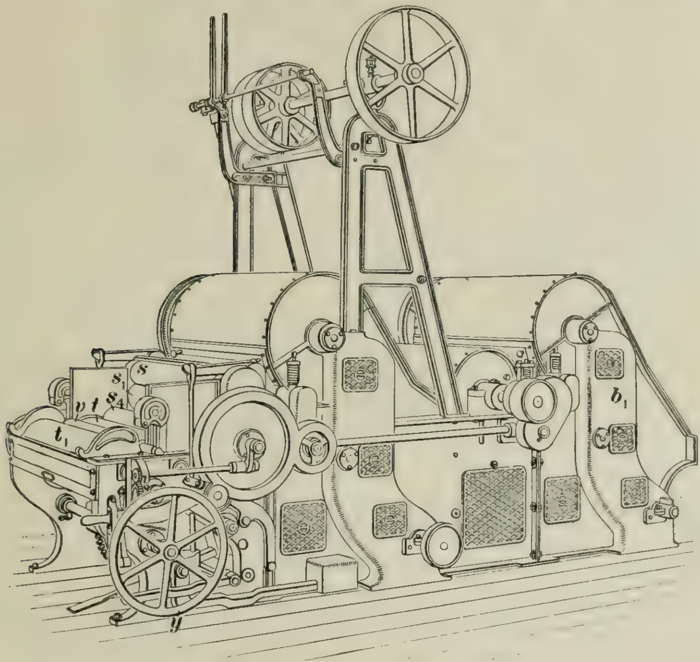


Fig. 4

rolls f, g on to a stripping plate r, from which it is removed by the feed-rolls l, l_1 of the picker.

CONSTRUCTION AND OPERATION OF THE BREAKER PICKER

5. Objects of the Breaker Picker.—The objects of the breaker picker are: (1) To remove foreign matter, especially the heavier and larger impurities, such as dirt, pieces of seed, leaf, etc.; (2) to separate the tufts of cotton so that they may be more easily manipulated at the next process; (3) to form the cotton into a layer and wind it on a roll in a cylindrical form known as a **lap.**

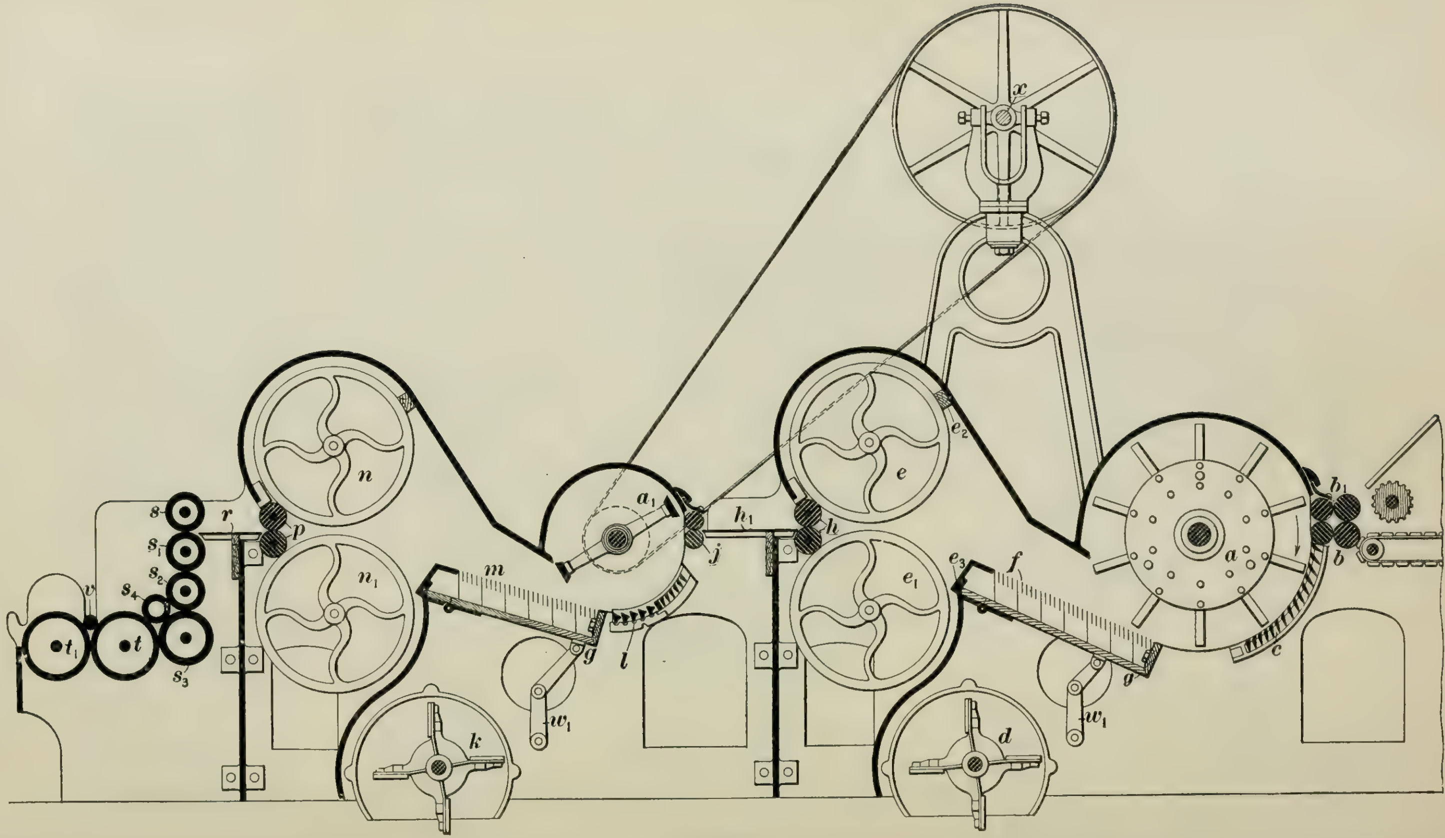


FIG. 5

The method used to attain these objects is to have a rapidly revolving *beater* strike a fringe of cotton, which is presented to it by a slowly revolving pair of feed-rolls, thus breaking up the sheet of cotton into small tufts and striking off any foreign matter in the cotton. The process of cleaning is also aided by an air-current, which draws dust from the cotton through screens, or cages, to which it is being drawn. These cages revolve and deliver the cotton in a sheet ready to be wound into a lap by means of a **lap head.**

6. Pickers are known as *pickers in single section* or *pickers in double section* according to whether they give a single or a double beating action to the stock passing through them. Breaker pickers in single section are shown in Figs. 1, 2, 3, and 4. The passage of cotton through breaker pickers in single section, whether they are fed by a condenser and gauge box, as in Fig. 1, or by a cage section, as in Fig. 3, is the same. Referring to Fig. 1, after the cotton delivered by the feed-rolls l, l_1 has been struck by the rapidly revolving beater a_1, it passes over grid bars c_2 in order that any dirt or other foreign matter may be separated and fall through the spaces between the bars. Then it is carried over inclined cleaning, or grate, bars f so that other foreign matter, too heavy to be carried by the air-current, may have an opportunity of dropping through the spaces between the bars. This cleaning process is continued while the cotton collects in a layer on the surface of two revolving cages, or screens, e, e_1, through which a current of air is drawn by a revolving fan k. The cotton, now in the form of a sheet or layer, is removed by stripping rolls p, and allowed to pass over a stripping plate r, between smooth calender, or presser, rolls s, s_1, s_2, s_3, between rolls s_4 and t, and around the lap roll v that rests on the fluted calender rolls t, t_1, thus forming the lap x.

7. Fig. 5 shows a section through a breaker picker in double section with what is known as a *porcupine beater*. This picker is connected directly to an automatic feeder by means of an apron, a portion of which is shown. In case a picker in double section is fed by trunking from

an opener and feeder combined, the cotton is delivered to a cage section similar to that shown in Fig. 3, while a beater of the type shown at a_1, Fig. 5, usually replaces the porcupine beater.

Referring to Fig. 5, as the cotton is delivered to the picker by the feed-apron, it is taken by feed-rolls b, b_1, from which it is struck by a beater a that is rapidly revolving in the direction shown by the arrow. It then passes over grid bars c, through which dirt and other foreign matter fall; then over inclined cleaning, or grate, bars f to cages e, e_1, from which it is delivered in a sheet to rolls h. These rolls deliver it to a stripping plate h_1, from which it is taken by

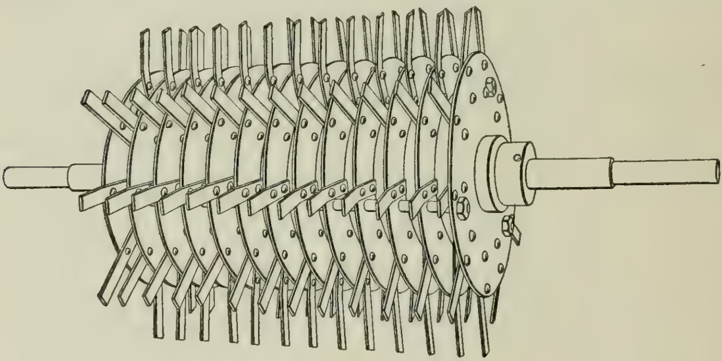


FIG. 6

rolls j and delivered to a beater a_1, which strikes it down over grid bars l. It then passes over cleaning bars m to cages n, n_1, which deliver it in a sheet to rolls p, from which it passes over a stripping plate r; then between rolls s, s_1; s_1, s_2; s_2, s_3; under roll s_4, over roll t, and is finally wound in the form of a lap on a lap roll v.

8. Types of Beaters.—There are several types of beaters, that known as a **porcupine beater** being shown in elevation at a, Fig. 5, and in perspective in Fig. 6; it consists of steel projections riveted to circular metal plates. This style is a special make and is most frequently found on openers. A **carding beater** is shown in section in Fig. 7,

and in perspective in Fig. 8; this beater has been adopted in recent years. It consists of three wooden lags *a*, *a*, *a* that are securely fastened to the arms *b*, *b*, *b* of the beater, which is mounted on the shaft *c*. Steel pins *d*, *d*, *d*, arranged spirally, project from the lags, those pins that first come in contact with the cotton being shorter than the others, as shown in Figs. 7 and 8. With this arrangement, the pins penetrate and break up the cotton, and as they enter it gradually, the strain incident to the operation of picking is almost equally distributed among them, causing the beater to combine a carding and a beating action. The carding beater is used to the greatest extent in breaker pickers and sometimes, though not often, in intermediate pickers.

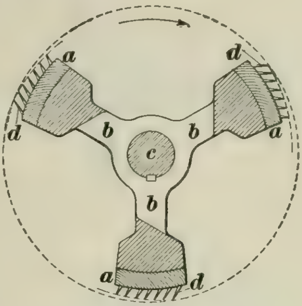


FIG. 7

Another type, and one that is more commonly met with, is known as the **ordinary knife, or rigid-blade, beater.** A two- and a three-blade beater of this type are shown in perspective in Figs. 9 and 10, respectively. The edges of the blades should not have a knife edge, neither should they

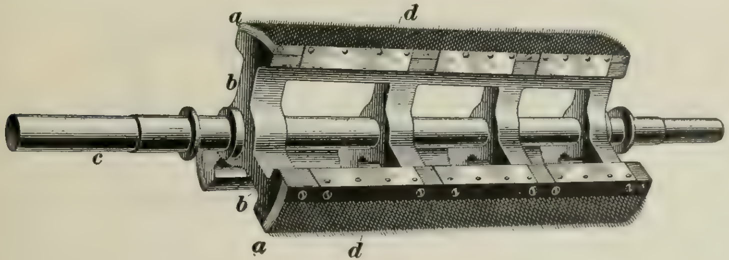


FIG. 8

be too blunt. As soon as the edges wear, the beater should be turned around so that the other edges of the blades will come in contact with the fringe of cotton. When both sides are dull, sufficient metal should be planed from the blades to give two new edges on each. Sometimes, beaters

are constructed with hardened steel edges fastened to the blades; these edges may be replaced when necessary.

9. Action of the Beater.—The action of the beater is the most important part of picking; for it is desired not only to clean the cotton, but also to do this with as little injury

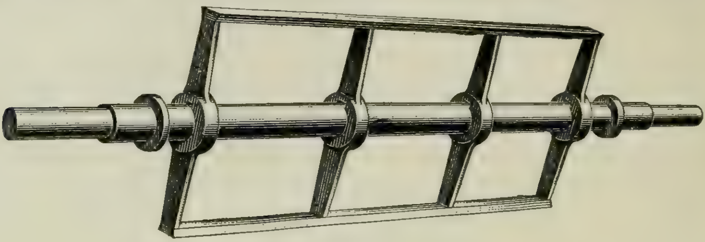


FIG. 9

to the fibers as possible. The speed of the beater must therefore be so regulated that the blades will not strike the cotton too often and thus injure the staple; neither should the speed be so low that they will not strike the cotton often enough and thus not clean it sufficiently. Beaters as a rule should not strike more than about 60 nor less than 20 blows per inch of cotton fed.

The speeds of beaters vary considerably, but the following

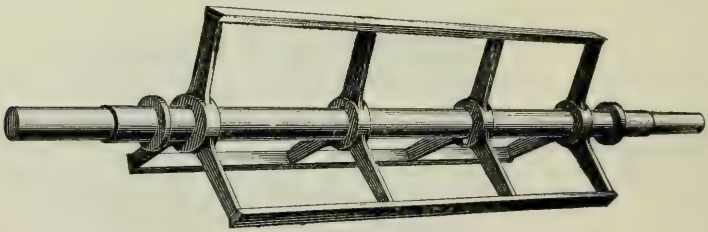


FIG. 10

are about the maximum and minimum for the different machines and types:

Porcupine beater, 30 inches in diameter, in opener, 500 to 600 revolutions per minute; 18-inch, two-blade, ordinary knife beater in breaker, 1,400 to 1,600 revolutions per minute; 20-inch, three-blade, ordinary knife beater in breaker, 850 to

1,050 revolutions per minute; 16-inch, two-blade, ordinary knife beater in intermediate or finisher, 1,250 to 1,500 revolutions per minute; 18-inch, two-blade, ordinary knife beater in intermediate or finisher, 1,200 to 1,450 revolutions per minute; 18-inch, three-blade, ordinary knife beater in intermediate or finisher, 800 to 950 revolutions per minute.

10. The **grid bars** through which the beater knocks the impurities are important agents in the cleaning of the cotton. They are triangular in section and extend from one side of

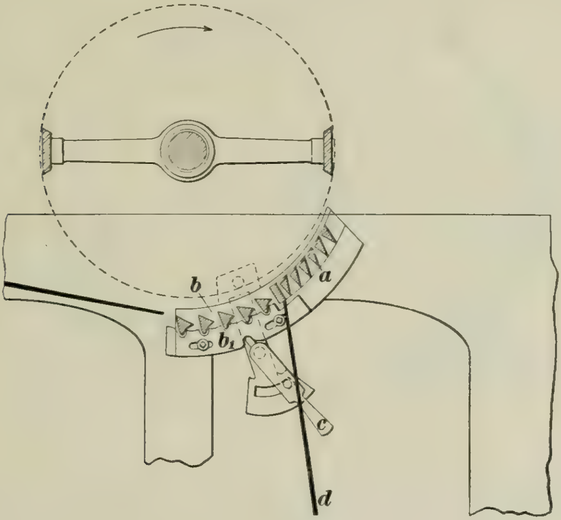


FIG. 11

the machine to the other. There are a sufficient number of them to occupy an arc of a circle extending for about a quarter of the path of the beater. When using 1-inch American cotton, the bar nearest the feed-roll is usually set in such a manner that the beater blade in revolving will be about $\frac{1}{2}$ inch from it when at its nearest point, while the last bar should be about $\frac{3}{4}$ inch from the beater blade when at its nearest point. Thus, the arc of the circle formed by the bars is not concentric with that formed by the path of the beater blade. The reason for setting the bars in this manner

is that the cotton expands and tends to fly from the beater blade, as the beater revolves, and thus would come against the bars if they were too near. The angle at which the bars are set, as well as the distance between them, also form important points in the setting of this part of the picker. The bars close to the feed-roll should have more space between them than those more distant. For 1-inch American cotton, there is usually about $\frac{1}{2}$ inch from edge to edge of the first three bars, while the lower bars are about $\frac{3}{8}$ inch apart.

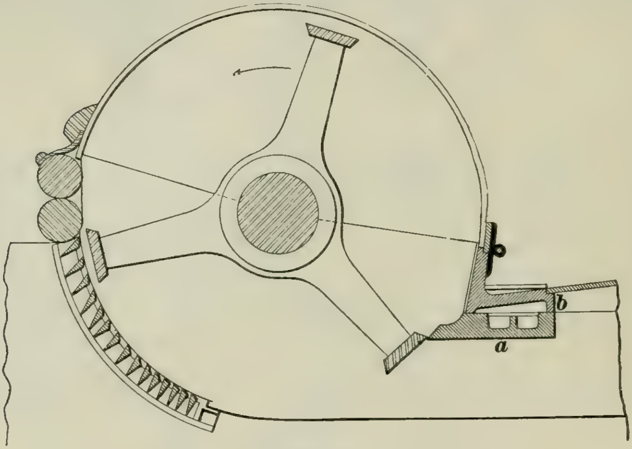


Fig. 12

11. An adjustment for **setting the grid bars** is shown in Fig. 11. The upper six bars *a* are of the ordinary pattern and through these the heavier forms of leaf and dirt are ejected by the action of the beater. The dirt that passes through these bars falls into a separate chamber, and, as the small capacity of this chamber will prevent any strong current issuing in the opposite direction through the bars, the impurities are prevented from returning. This advantage is further augmented by arranging the last five bars *b* so that they are adjustable. By this means an almost perfect regulation of the current of air passing upwards through the bars *a* can be obtained; for, the more air passing through the bars *b*, the less will pass through the bars *a*. The bars *b*

are also arranged to prevent by their shape, as far as possible, any return of dirt that may be driven through them by the beater. The adjustment is made by means of sliding plates b_1, into which the lower parts of the bars loosely fit. These plates can be moved backwards or forwards by a handle c, which, when set correctly, can be firmly fixed in position. The division plate d is an important factor and must be set accurately to obtain the best results.

12. Stripping Rail.—As soon as the cotton is released from the feed-rolls b, b_1, Fig. 5, it is acted on by the beater and then by an air-current that is generated by the fan d.

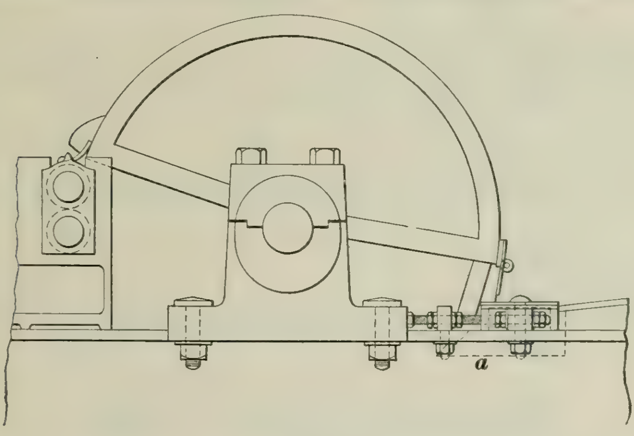


FIG. 13

This fan exhausts the air in the passage between the beater a and the cages e, e_1, and thus the air rushes in from the room through the opening shown in the side of the picker, passes through the grid bars c, through the passage to the cages, out at the ends of the cages, and down a flue to the dust room. By this means the cotton is carried through the passage over the cleaning bars f to the cages e, e_1. The top of the passage projects to some extent toward the beater and supports what is known as the **stripping rail**, one type of which is shown in Figs. 12 and 13 at a. It is the function of this rail to remove any cotton that has adhered to the beater instead of being carried to the cages. In some cases

the stripping rail cannot be moved, while in other cases it is capable of being adjusted. The type of stripping rail shown in Fig. 12 is an adjustable one, as the rail *a* is entirely separate from its support *b*. The adjustment for the stripping rail is shown in Fig. 13. Although the stripping rail is described in connection with a porcupine beater, it is generally and more appropriately used in connection with two- or three-blade beaters.

13. Inclined Cleaning Bars.—The bottom of the passage between the beater and the cages is formed by the series of cleaning bars *f*, Fig. 5, known as the **inclined cleaning**, or **grate, bars**. These bars are so placed that any foreign matter that is too heavy to be carried along by the air-current will drop of its own weight through them and thus be prevented from reentering the cotton. Every fifth bar is a deep one, in order to prevent the dirt that drops between the bars at a point nearest the cages from sliding down the incline. If this were not provided for, considerable dirt would accumulate at the lowest point of the incline and make it possible for a portion, at least, to reenter the cotton, as underneath these bars is a door *g*, Fig. 5, that is held in place by a weight on a lever, a portion of which is shown at w_1. This door can be lowered, in order to remove the dirt that has accumulated, but the picker should be stopped when this is done so that the air-current will not enter the passage to the cages through the grate bars and thus take some of the dirt with it into the cotton that is being drawn to the cages.

The cages e, e_1, Fig. 5, on which the cotton is delivered from this passage, are similar in construction to those that have been described, and are usually about 22 inches in diameter; in some cases, the top one is larger than the bottom one, or vice versa.

14. At a point e_2, Fig. 5, is a block that prevents air or cotton from being drawn to the surface of the upper cage beyond this point; the framework e_3 accomplishes the same object for the bottom cage. These cages are also usually

protected at the ends and other places so that the cotton cannot be drawn to any point but that nearest the passage. The cages aid in the cleaning of the cotton, since, as it is brought with some force against them, dust and foreign matter small enough to go through will be carried to the dust room. In addition to this, the cages, by revolving,

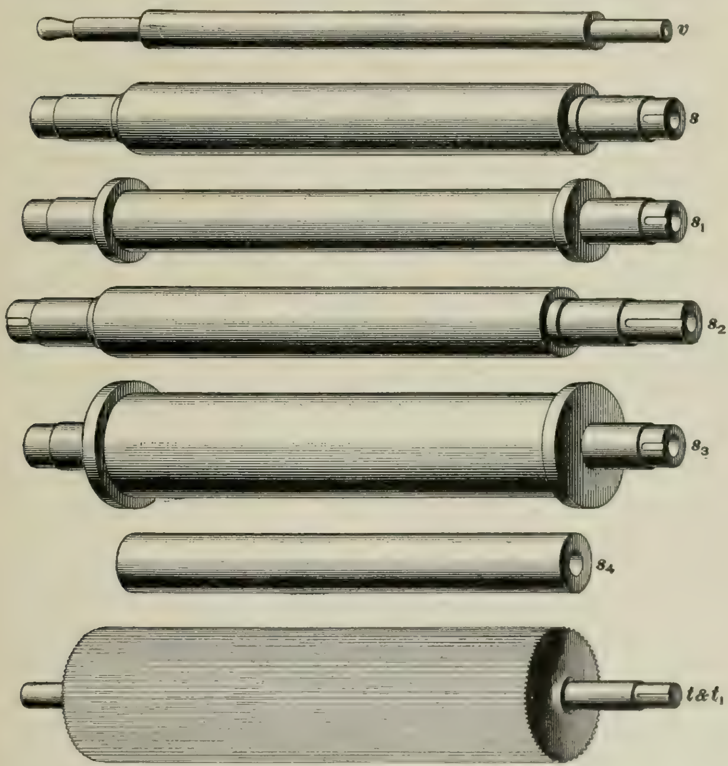


FIG. 14

form the cotton into a layer, which is taken by the stripping rolls *h* and delivered on the stripping plate h_1.

The cotton next passes over this stripping plate and is gripped by the feed-rolls *j*; in passing from these to the stripping rolls *p*, it is treated in the same manner as during its passage from the feed-rolls *b*, b_1 to the stripping rolls *h*.

In this section of the picker, however, there is a different type of beater, and the air-current is generated by the fan *k*, the air passing in through the grid bars *l*, and carrying the cotton over the cleaning bars *m* on to the cages n, n_1, from which it is stripped by rolls *p* and delivered on to the plate *r*. The cotton passes from the plate *r*, between the rolls *s* and s_1, then between s_1 and s_2, between s_2 and s_3, and under the compression roll s_4. The object of the last roll is to further condense the cotton. It has no bearings, being held in position by the rolls s_3, t and receiving motion by frictional contact with them; this roll is also shown at s_4, Fig. 14. The rolls s, s_1, s_2, s_3 are known as **smooth calender rolls,** and their purpose is to condense the layer of cotton. Their bearings are held in vertical slides, so that they are capable of being separated slightly when an excessive amount of cotton passes through. If they were held in fixed bearings, considerable strain would be brought on them at such a time. Two of these rolls that are not adjacent are constructed with collars, so that the four rolls fit into each other, as shown in s, s_1, s_2, s_3, Fig. 14. In addition to their own weight, downward pressure is exerted at each end by a weighted lever attached to two rods, one suspended from each side of a saddle resting on the bearings of the upper roll.

15. Lap Roll.—Between and resting on the fluted calender rolls t, t_1 is the lap roll *v*, which is held in position as shown in Fig. 5. This roll is revolved by frictional contact with *t* and t_1, and serves to roll the cotton into a cylindrical form known as a **lap.** When the lap has reached the desired size, the lap roll is withdrawn and the lap removed from the machine. The lap roll, which is also shown in Fig. 14 at *v*, is built in two styles; sometimes it is solid, and when the lap is used at a succeeding process a rod is pushed through the opening thus made, while in other cases it is hollow, so that a rod having a large, flat head may be inserted while the lap is still on the lap roll and thus be in position when the roll is withdrawn from the lap.

16. Lap Rack.—In order to build a solid lap, a device known as a **lap rack** is employed, the construction of which is shown in Fig. 15 (*a*) and (*b*), Fig. 15 (*a*) being a side

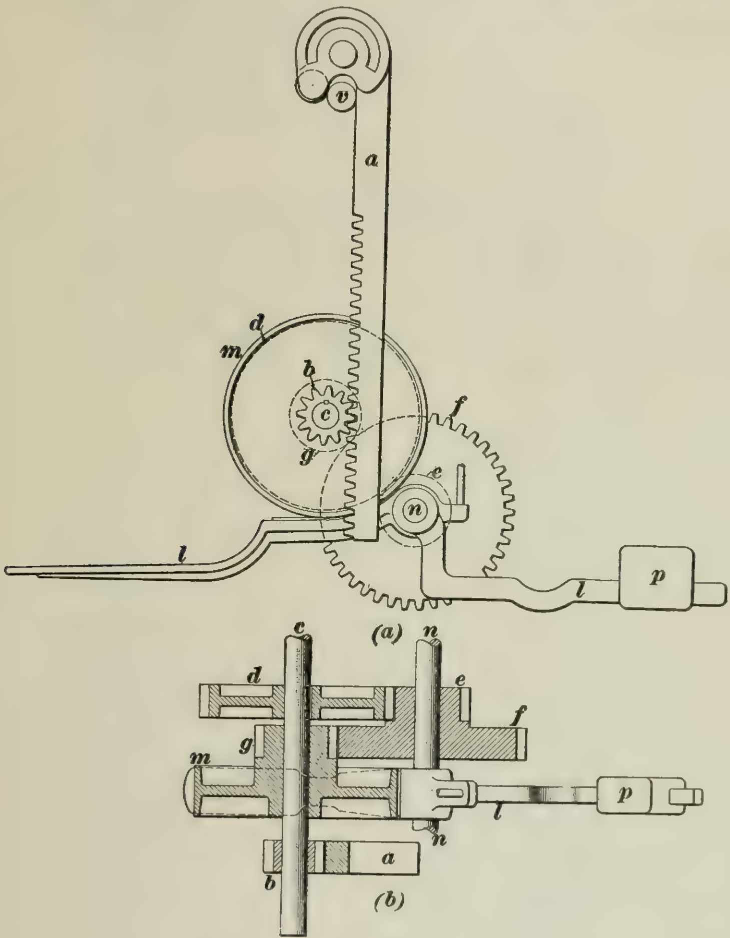
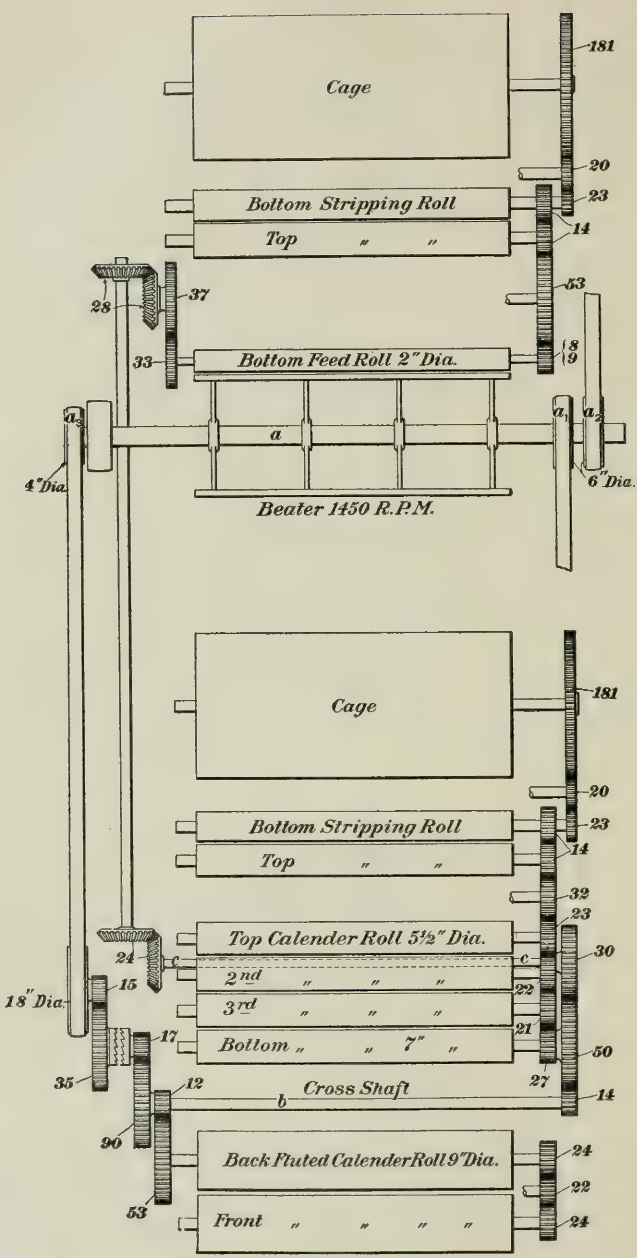


Fig. 15

elevation and Fig. 15 (*b*) a plan view, partly in section. At each end of the lap roll *v* is the lap rack *a*, the upper part of which has a bearing on the lap roll; the lower part has teeth that engage with a gear *b* on the shaft *c*. Fixed to the shaft *c*



Cage
181
20
23
Bottom Stripping Roll
Top " "
14
53
37
28
8
9
33
Bottom Feed Roll 2" Dia.
a_3
a
a_1
a_2
4" Dia.
6" Dia.
Beater 1450 R.P.M.
Cage
181
20
Bottom Stripping Roll
23
Top " "
14
32
23
Top Calender Roll 5½" Dia.
24
c
c
30
2nd " " "
22
15
18" Dia.
3rd " " "
21
17
Bottom " " 7" "
50
35
12
Cross Shaft
b
27
14
90
Back Fluted Calender Roll 9" Dia.
24
22
53
Front " " " "
24

FIG. 16

is a gear d that meshes with a gear e on a sleeve on the stud n. This sleeve also carries another gear f that meshes with the gear g loose on the shaft c and compounded with the friction pulley m. Pressing against this friction pulley is a strip of leather, which is held against it with considerable pressure by means of the weight p on the lever l fulcrumed on n.

As the lap increases in size on the roll v, it must overcome the total resistance of the friction pulley and the friction of the gearing; by this means it is made comparatively firm. When it is necessary to remove the lap, the friction is released by depressing the end of the lever l, opposite to the weight p, with the foot. The cotton then has a tendency to expand, which will lift the racks a, to some extent, but they are further raised by means of a hand wheel, shown at y, Figs. 2 and 4, and which is on the shaft c, Fig. 15 (a).

17. Gearing.—Above the machine in Fig. 5 is shown a framework carrying a countershaft x. The speed of the beater is so high that it cannot be driven directly from the main shaft of the room without using very large pulleys; for this reason, the countershaft is used and the beater driven from it as shown in Fig. 5. In some cases instead of being on the machine the countershaft is attached to the ceiling.

A plan of gearing for a picker in single section having a cage section is shown in Fig. 16. On one end of the beater shaft a are two pulleys a_1, a_2; a_1 drives the fan that produces the air-current for the cages nearest the lap head, while a_2 drives the fan that produces the air-current necessary to draw the cotton from the trunking to the cage section. These pulleys are 6 inches in diameter and drive pulleys on the fan shaft 8 inches in diameter; therefore, when the beater shaft a is making 1,450 revolutions per minute, the speed of each fan is $\frac{1{,}450 \times 6}{8} = 1{,}087.5$ revolutions per minute.

On the other end of the beater shaft is a 4-inch feed-pulley a_3 driving an 18-inch pulley compounded with a 15-tooth gear, which, through two gears connected, or

compounded, by a clutch arrangement, drives a cross-shaft *b*, from which the fluted calender rolls receive motion. At the other end of the cross-shaft from the 12-tooth gear driving the fluted calender rolls is a gear of 14 teeth, driving a gear of 50 teeth, which is compounded with a gear of 27 teeth.

The method by which the calender rolls, stripping rolls, and top cage are driven from this gear of 27 teeth may be readily traced. The bottom cage is driven from the top cage. The 14-tooth gear on the cross-shaft *b* drives a 30-tooth gear on the end of another cross-shaft *c* through the 50-tooth gear. The shaft *c*, by means of bevel gears, drives a shaft extending along the side of the picker. The feed-rolls receive motion from this shaft, and the stripping rolls, together with the cages of the first cage section, are driven from the bottom feed-roll.

18. The cross-shaft *b* that carries the gear of 14 teeth is driven through the 18-inch pulley by a 35-tooth gear, a clutch gear, and a 17-tooth gear meshing with one of 90 teeth on the cross-shaft. When the clutch is disconnected, the lap head and the feed-rolls will stop, but the beater and fans will continue to run. When it is desired to remove a lap, this clutch is disconnected.

The reason for this construction is that the beater and fans, owing to their high speed, could not be stopped immediately when it was desired to remove a lap without putting an excessive strain on the beater; neither would it be advisable to start the beater and fans from a standstill each time the feed was started, since too much time would be required for these parts to acquire their maximum speed. By this construction, however, the cotton may be stopped or started through the picker almost instantly.

19. Draft of a Breaker Picker.—The draft of a breaker picker is usually a little less than 2, and is figured from the fluted calender rolls to the feed-rolls. The draft of the picker shown in Fig. 16 is

$$\frac{9 \times 24 \times 12 \times 30 \times 24 \times 28 \times 33}{24 \times 53 \times 14 \times 24 \times 28 \times 37 \times 2} = 1.947$$

20. Floor Space of a Breaker.—The floor space of a breaker varies according to the style and make of the machine. One type of a single-beater breaker with a cage section occupies a floor space of 13 feet 9 inches by 6 feet $8\frac{1}{2}$ inches, allowing for trunk connections. A double-beater machine, other particulars as above, occupies 19 feet 10 inches by

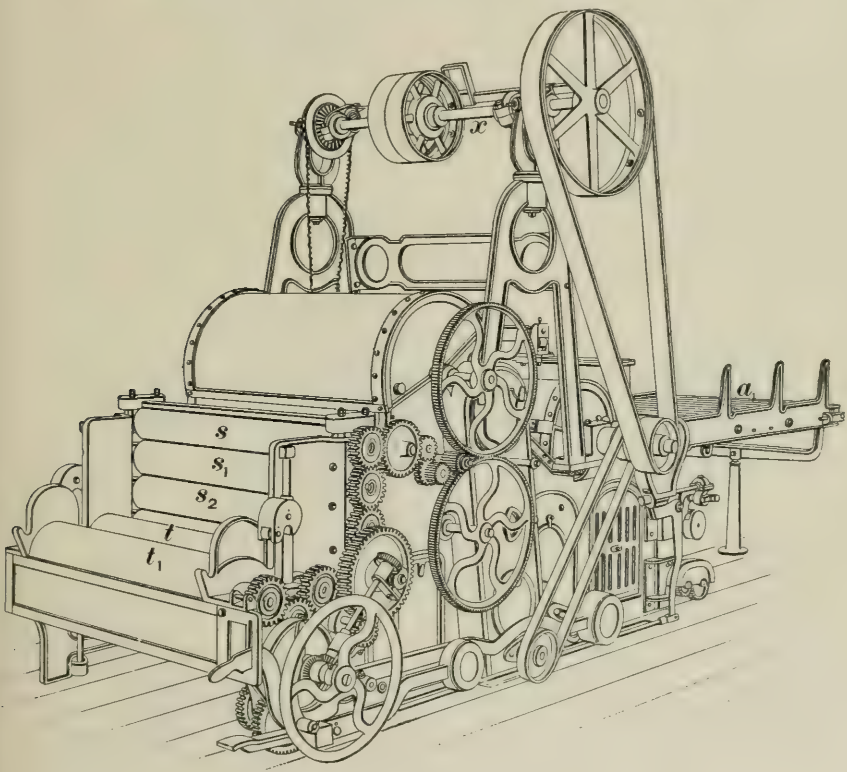


FIG. 17

6 feet $8\frac{1}{2}$ inches. Where a condenser and gauge box are used instead of a cage section, from 7 to 9 inches may be deducted from the length given above. These measurements are for pickers that make laps 40 inches wide.

When in single section, breaker pickers require about $4\frac{1}{2}$ horsepower; when in double section, about 7 horsepower.

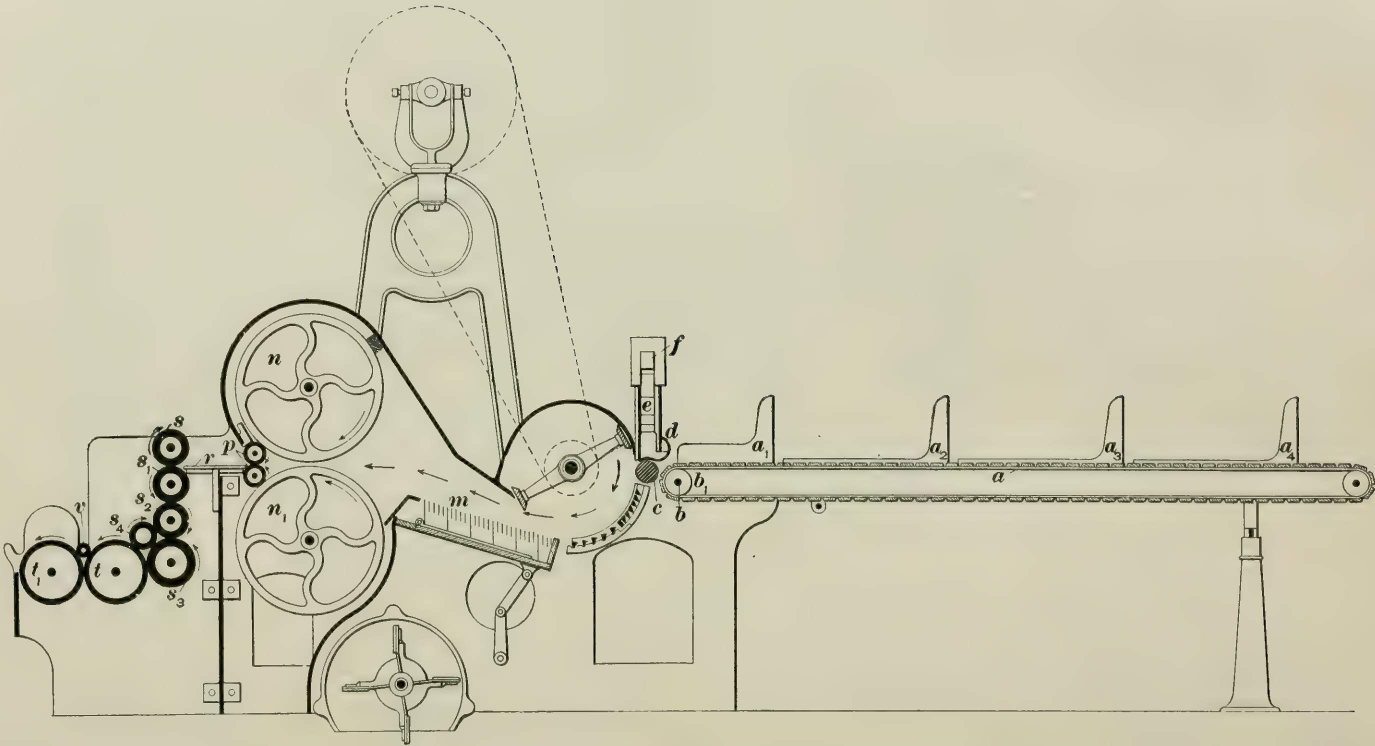


Fig. 18

The production depends on the speed, width of lap, and weight of lap per yard. A common production is about 500 pounds per hour, or 25,000 pounds for a week of 50 hours actual running time, as about 8 hours is allowed for stoppages.

INTERMEDIATE AND FINISHER PICKERS

21. **Intermediate and finisher pickers** are practically alike in construction and differ very little from a breaker picker in single section. Their objects are the same as those of the breaker picker; the lap that they produce, however, is of a more uniform weight per yard.

Fig. 17 shows a perspective view of a finisher picker, while Fig. 18 shows a section through the same machine. Four

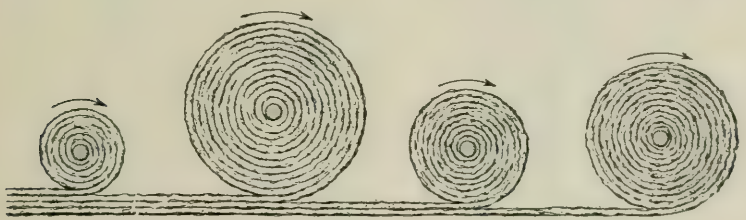


FIG. 19

laps taken from the previous picker are placed on the apron *a*, and thus the advantage gained by doubling is secured.

22. Fig. 19 shows how the laps pass under each other on the apron that conducts them to the feed-rolls. Rods passing through the centers of these laps and being in contact with the brackets a_1, a_2, a_3, a_4, Fig. 18, hold the laps in position.

The laps, shown in Fig. 19, vary in diameter. This is necessary in order to keep four layers of cotton supplied to the feed-rolls at all times. If all the laps were of the same diameter, they would run out at the same time, and thus there would be a liability of the cotton running through the machine before all the new laps were supplied, as well as a tendency to irregularity through four piecings coming near together.

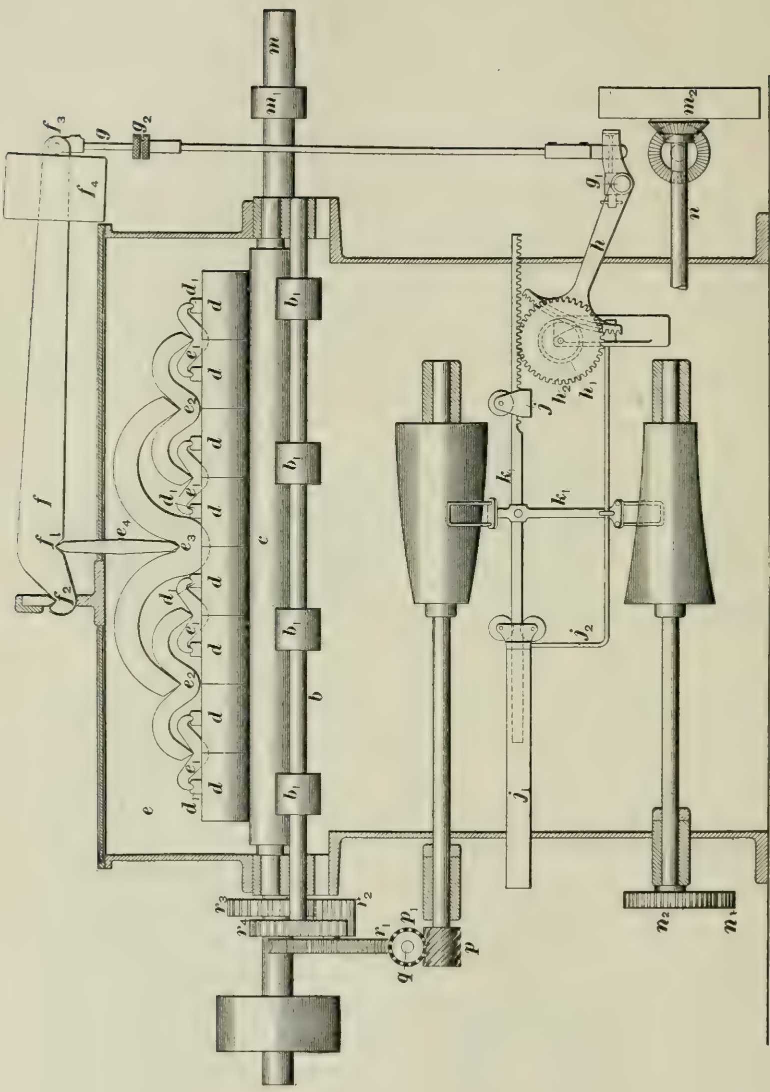

m
m_1
m_2
n
n_1
n_2
f
f_1
f_2
f_3
f_4
g
g_1
g_2
h
h_1
h_2
j
j_1
j_2
k
k_1
e
e_1
e_2
e_3
e_4
d
d_1
c
b
b_1
p
p_1
q
r_1
r_2
r_3
r_4

FIG. 20

EVENER MOTIONS

23. After it is delivered by the feed-rolls, the cotton is treated in the same manner as in the breaker picker, but the manner in which it is fed into the intermediate and the finisher pickers is somewhat different from that in a breaker picker, as indicated by the curved section plate *d* above the roll *c*, Fig. 18. This section plate is a portion of a motion known as the **evener motion,** the object of which is to regulate the speed of the feed-roll in accordance with the weight of cotton fed so that a uniform weight will be presented to the beater.

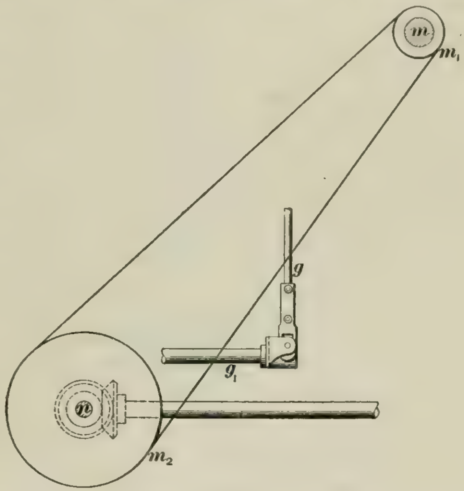


FIG. 21

Fig. 20 is a complete view of all the attachments of an evener, while Figs. 21 and 22 are portions of side elevations. A shaft *b*, Fig. 20, carries rolls b_1, which give motion to and support the feed-apron *a*, Fig. 18, while *c*, Fig. 20, is a feed-roll, or evener roll, extending across the machine.

24. Scale Box.—Fig. 20 shows eight sectional plates *d*, each of which is about 5 inches in width, and carries a projection d_1 that passes inside a box known as the **scale box** *e*. The plates are connected in pairs by four short saddles e_1. Each pair of these saddles e_1 is, in turn, connected by a larger saddle e_2, while the centers of e_2 are connected by a still larger saddle e_3.

Extending from the center of the saddle e_3 is a pin e_4, which projects out of the scale box and forms a bearing for

a lever f at f_1. The fulcrum of the lever is at f_2 and is formed by a bracket fastened to the scale box. At the other end of the lever, fastened at f_3, is a vertical rod g that is connected to a short shaft g_1 at the side of the picker. At the opposite end of this shaft is fastened a segment h, the teeth of which engage with a gear h_1. This

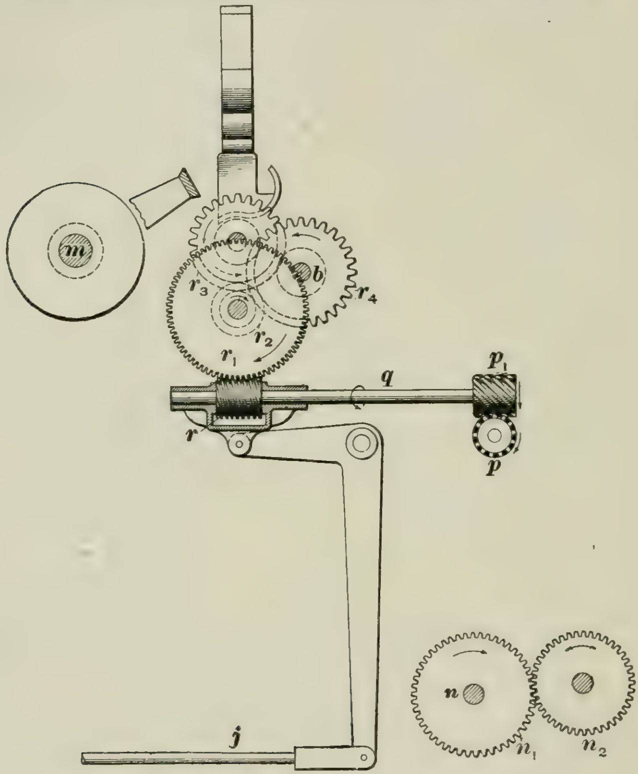


Fig. 22

gear is on a sleeve with a gear h_2, the sleeve being supported by a stud that projects from a bracket bolted to the framework under the apron. Supported from this same part of the machine are bearings j, j_1 that hold a rack k in position. The teeth of this rack engage with the teeth of the gear h_2.

25. Connected to the rack k is a belt guide k_1 that controls the position of the belt on the cones and thus regulates the speed of the driven cone. A rod j_2 that extends downwards from the bearing j_1 and then horizontally through a projection on the belt guide serves to steady the guide.

26. Feed-Roll.—The manner in which the feed-roll is driven through the cones may be seen by reference to Figs. 21 and 22 in connection with Fig. 20. On the beater shaft m is a pulley m_1 driving a pulley m_2 on a shaft n that extends across the picker. The lower-cone shaft is driven from the shaft n by the gears n_1, n_2, while motion is imparted to the top-cone shaft by a belt that passes around both cones.

On one end of the top-cone shaft is a spiral gear p, Figs. 20 and 22, that drives a spiral gear p_1 on a short shaft q. At the other end of this shaft is a double worm r that drives a worm-gear r_1 of 78 teeth. Compounded with the gear r_1 is a gear r_2, which is of extra width so that it drives a gear r_3 on the feed-roll and also a gear r_4 on the apron shaft b.

27. Operation.—The manner in which this evener regulates the speed of the feed-roll in accordance with the weight of cotton fed is as follows: The sectional plates d, Fig. 20, are pressed down on the roll c by the weight f_4, shown on the lever f, through the connection made by e_4 and the saddles. The distance that these plates are raised from the roll c is governed by the amount of cotton that passes between them and the roll; and, by following the connections, it will be seen that the distance these plates are raised will govern the position of the belt on the cones, and, consequently, the speed of the roll c that feeds the cotton.

When the proper weight of cotton is being fed uniformly throughout the length of the feed-roll c, the plates are raised the same distance from the roll c and the belt should be exactly in the center of the cones. If, however, a portion of cotton 1 inch thicker than the average thickness comes under the section plate at the extreme left, this section plate will be raised 1 inch from its normal position. The result of this will be that the end of the lever e_1 resting on this plate will

be raised 1 inch, which in turn will raise the end of the lever e_2 connected to e_1 $\frac{1}{2}$ inch. The end of the lever e_3 that is connected to this lever e_2 will therefore be raised $\frac{1}{4}$ inch, which, by causing the pin e_4 to be raised $\frac{1}{8}$ inch, will result in the lever f being raised $\frac{1}{8}$ inch at the point f_1.

As the lever f cannot rise at f_2, its other end must rise and, through the rod g, turn the shaft g_1. The segment h

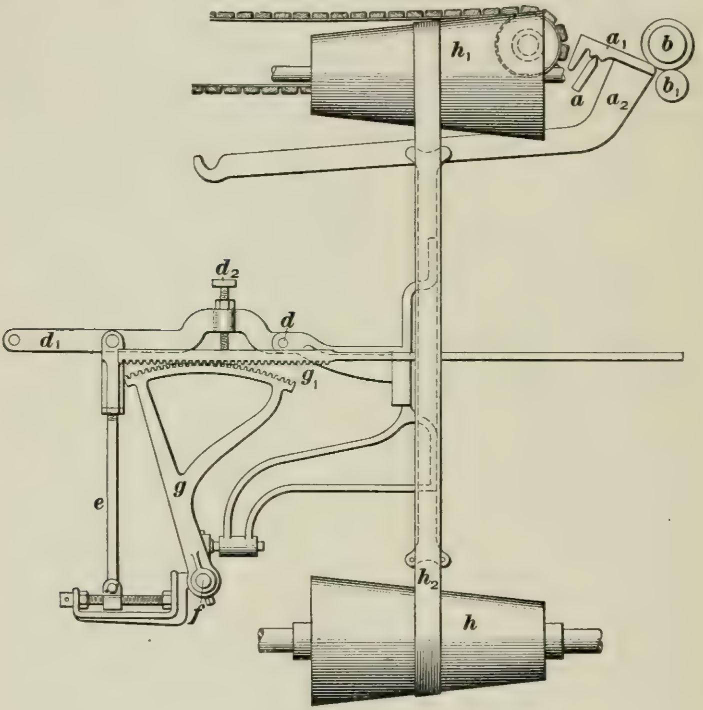


Fig. 23

will therefore be moved, and through the gears h_1, h_2 and the rack k, the belt will be guided on to the smaller part of the lower, or driving, cone, thus decreasing the speed of the feed-roll and reducing the weight of cotton fed. As soon as this heavier portion of cotton has passed and the correct weight is fed, the parts will be brought to their normal positions by means of the weight on the lever f.

In this illustration, an extreme case has been taken, as it is seldom that an extra portion of cotton 1 inch thicker than the average comes under one of the section plates; but the belt would be moved the same distance if a portion of cotton $\frac{1}{8}$ inch thicker than the average should come under all the section plates. If four of the plates are raised $\frac{1}{4}$ inch from

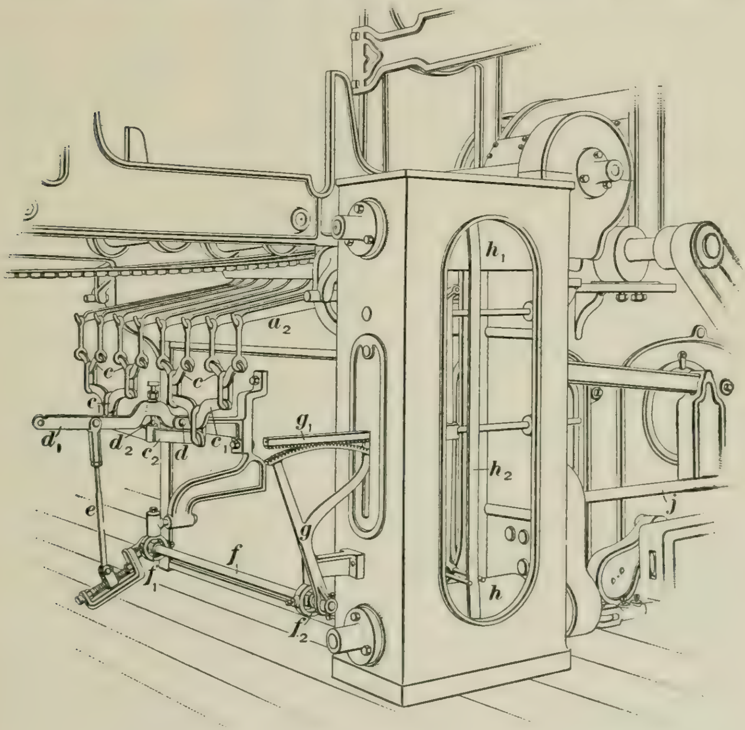


FIG. 24

their normal position, it will have the same effect as raising each plate $\frac{1}{8}$ inch. It is therefore obvious that the arrangement is designed to insure an average weight of cotton being fed regardless of the number of plates that are affected.

28. Another type of evener is shown in Figs. 23 and 24. Extending across the machine between the apron roll and

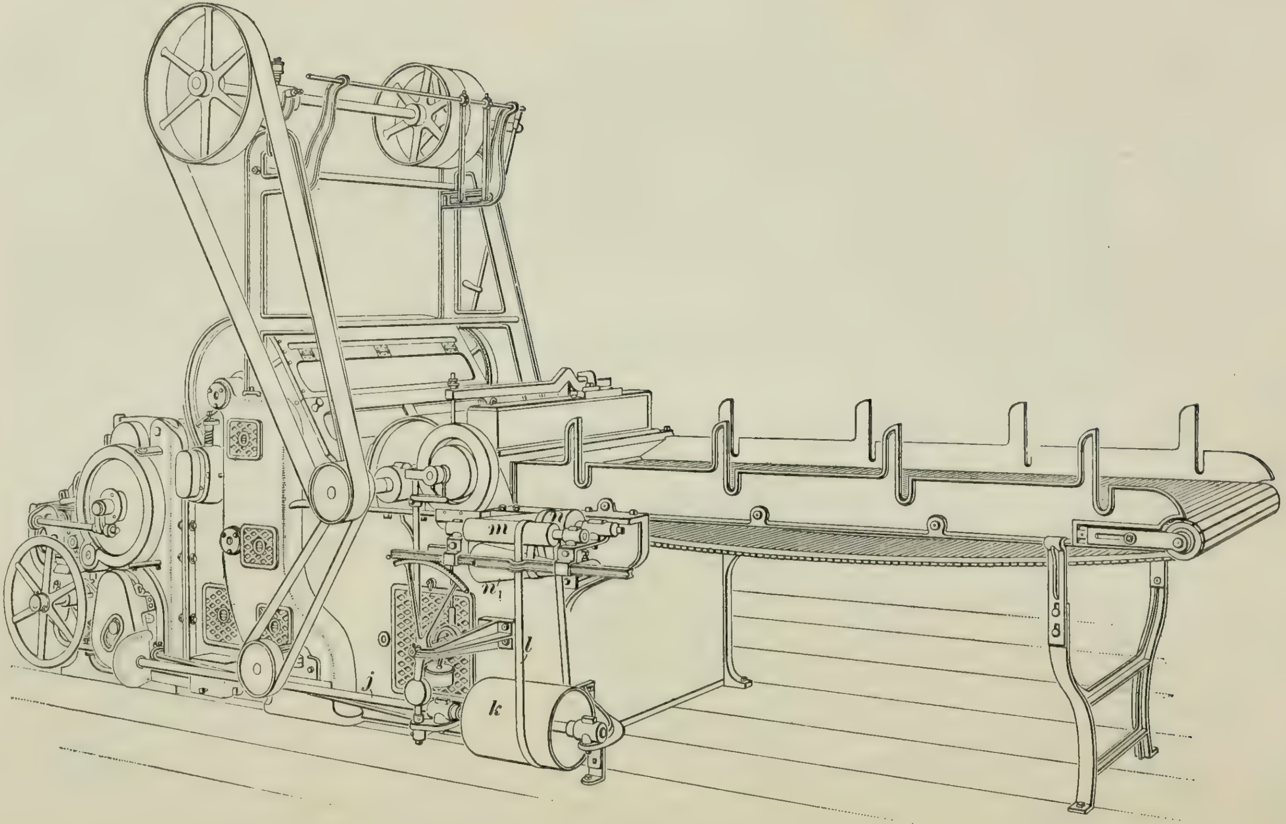


FIG. 25

the feed-rolls is a plate a, Fig. 23, that has a sharp edge on the top. Bearing on this are eight sectional plates a_1 that are in a position to be affected by the cotton just before it passes to the feed-rolls b, b_1. The lower feed-roll is smaller than the upper one, and thus the plates are allowed to lie under the upper one and so come very close to the bite of the rolls. Arms a_2 extend from these plates under the feed, or lap, apron, as shown in Figs. 23 and 24, and are connected in pairs by means of bridges c, c, which, in turn, are connected to a large bridge c_2, by means of two other bridges c_1, c_1. Fulcrumed at d is a lever d_1 that contains a screw d_2 having a bearing on the large bridge c_2. Extending from this lever d_1 is a rod e that connects with shaft f having bearings at f_1 and f_2. At the end of the shaft f nearest the bearing f_2 is attached a segment g, the teeth of which engage with a rack g_1 that governs the position of the belt h_2 on the cones h, h_1.

The bottom cone h is driven by gearing from the side shaft j, which receives motion from the lap head. The top cone h_1, driven by the bottom cone, drives the feed-rolls by means of a worm-drive; consequently, any movement of the belt on the cones will alter the speed of the feed-rolls and thus affect the weight of the cotton fed.

When the proper weight of cotton is being fed, the plates are all depressed the same distance; but, if a portion of cotton heavier than the average weight passes over a plate, this plate will be further depressed. As the plate is fulcrumed on a, this will cause the outer end of the arm a_2 to rise, which will result in the lever d_1 being raised through the connections made by the bridges c, c_1, c_2. The raising of the lever d_1 will impart motion to the shaft f by means of the connecting-rod e, which will cause the segment g to move the rack g_1 in such a manner that the belt h_2 will be moved to the small end of the driving cone. When the heavy portion of cotton has passed, the plate will be returned to its normal position by the weight of the arm a_2, together with the weight of the bridges, lever, and connecting-rod. If less than the average weight of cotton is presented to the

plates, the arm a_2 and the lever d_1, together with the bridges, will fall, because of their weight, and the result will be that the belt will be moved to the larger end of the driving cone, thus increasing the speed of the feed-rolls.

29. A picker with another type of evener motion attached is shown in Fig. 25. The scale box and its connections with the segment resemble those in Fig. 20. The rolls of this evener, however, instead of being driven merely through cones, are driven by a combination of two cones, a drum, and a roll.

The manner in which this method of driving is arranged can be readily traced. A side shaft j, Fig. 25, that carries a drum k at one end receives motion from the lap head. A belt l from the drum k passes first over a roll m and then around the cones n_1, n. The feed-rolls receive their motion through a worm-drive from the top cone n.

It is possible to attach eveners to automatic feeders, although this is not commonly done, since the effect of the evener on the uniform weight of cotton is destroyed to some extent during its passage from the feeder to the breaker picker, especially if an opener is used and the cotton is conveyed from it to the breaker picker by trunking.

MEASURING MOTION

30. The **measuring motion** is used to a greater extent on intermediate and finisher pickers than on breaker pickers. Its object is, when a definite length has been wound on the lap roll, automatically to stop the feed-rolls, the smooth calender rolls, and in some cases the fluted calender rolls, while the beater shaft and fans continue to revolve.

A view of a measuring motion, the value of the gearing of which is given later in this Section, under Gearing, is shown in Fig. 26; a represents the end of the bottom calender roll, carrying a worm b, which through a worm-gear c drives a shaft c_1 carrying a bevel gear d, which drives a bevel gear e. The gear e, together with a dog f, is loose on a stud g and carries a projection e_1, the dog f also carrying a projection f_1.

The dog, if allowed to do so, would fall because of its own weight so that its point would be down, but as the gear e receives motion from the bottom calender roll, the projection e_1 on the gear e comes in contact with the projection f_1 on the dog f and thus continually forces the dog around ahead of it; consequently, when the projection e_1 is at its highest position, the parts mentioned occupy the position shown in Fig. 26.

As the gear e continues to revolve, the dog f will be brought in contact with a projection on a lever h that is

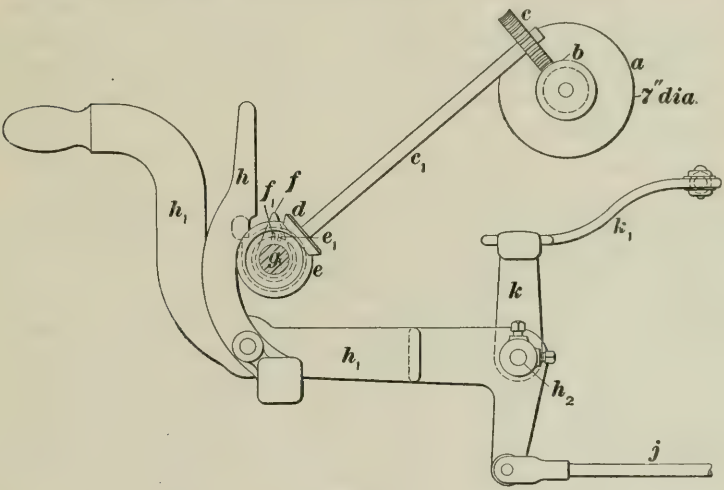


FIG. 26

connected to the starting lever h_1 fulcrumed at h_2. Connected to h_1 is a rod j, Figs. 22 and 26, that runs along the side of the picker and connects with a double worm r, Fig. 22. A bracket k, Fig. 26, is also attached to the rod h_2, while attached to this bracket is a rod k_1 that connects with the clutch l, Fig. 27, through which the lap head is driven.

31. When the picker is running, the cut-out, shown in dotted lines, in the lever h, Fig. 26, has a bearing on a casting, and thus the starting lever h_1 is held in such a position that the worm r, Fig. 22, is in contact with the worm-gear r_1,

the clutch *l*, Fig. 27, being closed. When, however, the gear *e*, Fig. 26, has made one revolution and has brought the dog *f* into contact with the lever *h*, any further movement causes the dog *f* to force the cut-out on *h* from its bearing. This causes the starting lever h_1 to drop, disconnecting the clutch *l*; the worm *r* is also thrown out of gear, causing the calender rolls and the feed-rolls to stop.

In some cases, the gearing is so arranged that only the smooth calender rolls and the feed-rolls stop, while the fluted calender rolls continue to run, thereby resulting in the lap of cotton being broken away from the sheet of cotton held by the rolls that have been stopped. In other cases the fluted calender rolls stop and the lap is broken from the cotton in the machine by giving it a partial revolution with the hands.

After the lap has been thus separated, the racks described in connection with Fig. 15 are raised, the roll *v* withdrawn, and the lap is removed from the machine. The starting lever h_1, Fig. 26, is then raised until the cut-out rests on the casting, thereby throwing the clutch *l*, Fig. 27, and the worm *r*, Fig. 22, into gear, and starting the cotton through the machine. The lap roll is then placed in position and the layer of cotton started around it by hand, after which the foot is placed on the lever *l*, Fig. 15, allowing the racks to descend by their own weight and hold the lap roll in position. This operation is repeated each time the gear *e* makes one revolution and releases the lever *h*, Fig. 26.

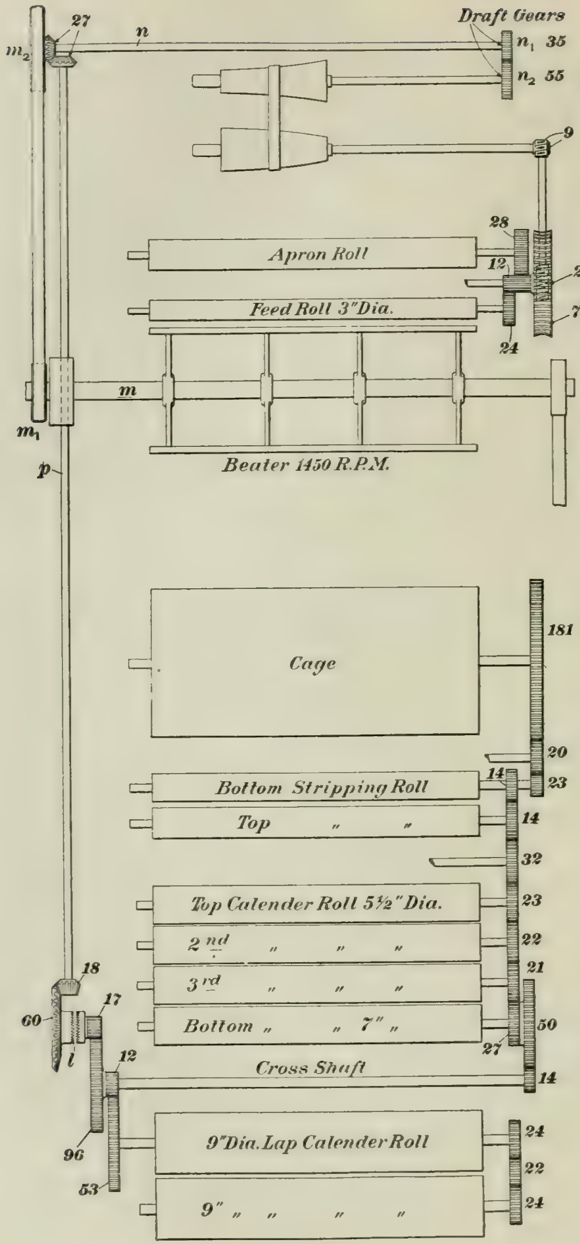
ADJUSTMENTS

32. The distance between the blade of the beater and the feed-rolls when in closest proximity is an important point in a picker. If this distance is too great, the fringe of cotton will not receive the full benefit of the beating process, and thus the impurities will not be properly removed or the cotton separated into sufficiently fine pieces. On the other hand, if the beater blade is set too close, the fibers of the cotton will be injured.

An adjustment is therefore provided for moving the feed-rolls nearer to, or farther from, the beater. The reason for moving the feed-rolls instead of the beater is that, as the feed-rolls revolve much more slowly than the beater, they would not be injured as much if, after changing their position, their bearings were not exactly in line. The distance between the blade of the beater and the feed-rolls is dependent principally on the length of the staple being run, the diameter of the feed-rolls, and the thickness of the cotton being delivered to the beater.

The longer the staple, the smaller the diameter of the feed-rolls, and the thicker the cotton being delivered, the farther the feed-rolls should be set from the beater. With 3-inch feed-rolls, and using 1-inch American cotton, the distance between the blade of the beater and the feed-rolls should be from $\frac{3}{16}$ to $\frac{5}{16}$ inch.

33. Evener Adjusting Screw.—Near the top of the rod g, Fig. 20, is shown an **adjusting screw** g_2. Sometimes, owing to atmospheric changes and other conditions, the weight of the cotton will vary; that is, it may feed a little heavier or a little lighter one day than another. This causes the weight of the lap per yard to vary also. As the same weight of lap per yard is usually required each day, an adjustment must be provided by means of which the variation may be reduced to a minimum. If the lap is delivered too heavy or too light per yard, a change, of course, can be made in the draft change gear, but in case the variation is very slight, a change of 1 tooth in the draft gear will probably cause too great an alteration. For this reason, therefore, the adjustment is provided on the rod g and, by turning the screw g_2 up or down on this rod, the belt may be moved on the cones, thus making a very slight change in the speed of the feed-rolls. All evener motions are provided with somewhat similar adjustments.



Draft Gears
27
n
m_2
n_1 35
n_2 55
9
28
Apron Roll
12
2
Feed Roll 3"Dia.
78
24
m
m_1
p
Beater 1450 R.P.M.
181
Cage
20
14
Bottom Stripping Roll
23
Top " "
14
32
Top Calender Roll 5½" Dia.
23
2 nd " " "
22
21
3 rd " " "
18
17
60
Bottom " " 7" "
50
27
l
12
Cross Shaft
14
24
9"Dia. Lap Calender Roll
96
22
53
9" " " " "
24

Fig. 27

GEARING

34. The gearing of a picker equipped with the evener motion illustrated in Fig. 20 is shown in Fig. 27. The beater shaft m is driven from a countershaft, as explained in connection with the breaker picker, and carries the usual pulleys for driving the fan and feed-rolls.

The feed-pulley m_1 drives a pulley m_2 on a shaft n extending across the picker. From this shaft, the cones and the feed-rolls, together with the feed-apron, are driven. As the feed-apron is driven through the cones, its speed will always be in accordance with that of the feed-rolls. The lap head, cages, and stripping rolls are driven through a side shaft p, which receives its motion from the shaft n. The driving plan of the picker shown in Fig. 25 is given in Fig. 28.

The measuring motion is provided with **change gears,** by means of which different lengths of laps can be procured. When finding the length of lap, the number of revolutions made by the bottom calender roll while the knock-off gear is revolving once should first be determined; this result multiplied by the circumference of the roll will give the length of lap. Referring to Fig. 26, the bottom calender roll a is 7 inches in diameter, b is a single worm, and the worm-gear c is the change gear; the gear d has 21 teeth, while the knock-off gear e contains 30 teeth.

The length of lap delivered when using a 45-tooth change gear is as follows: $\frac{30 \times 45}{21 \times 1} = 64.285$ revolutions of roll to one revolution of gear e. $64.285 \times 7 \times 3.1416 = 1{,}413.704$ inches. $1{,}413.704$ inches $\div 36 = 39.269$ yards, length of lap.

This example could also be expressed as follows:

$$\frac{30 \times 45 \times 7 \times 3.1416}{21 \times 1 \times 36} = 39.26 \text{ yards}$$

A constant for the measuring motion may be obtained by omitting the change gear or considering it a 1-tooth gear. This constant, multiplied by the number of teeth in any change gear, will give the length of lap delivered when using that gear, and consequently the gear for producing a certain

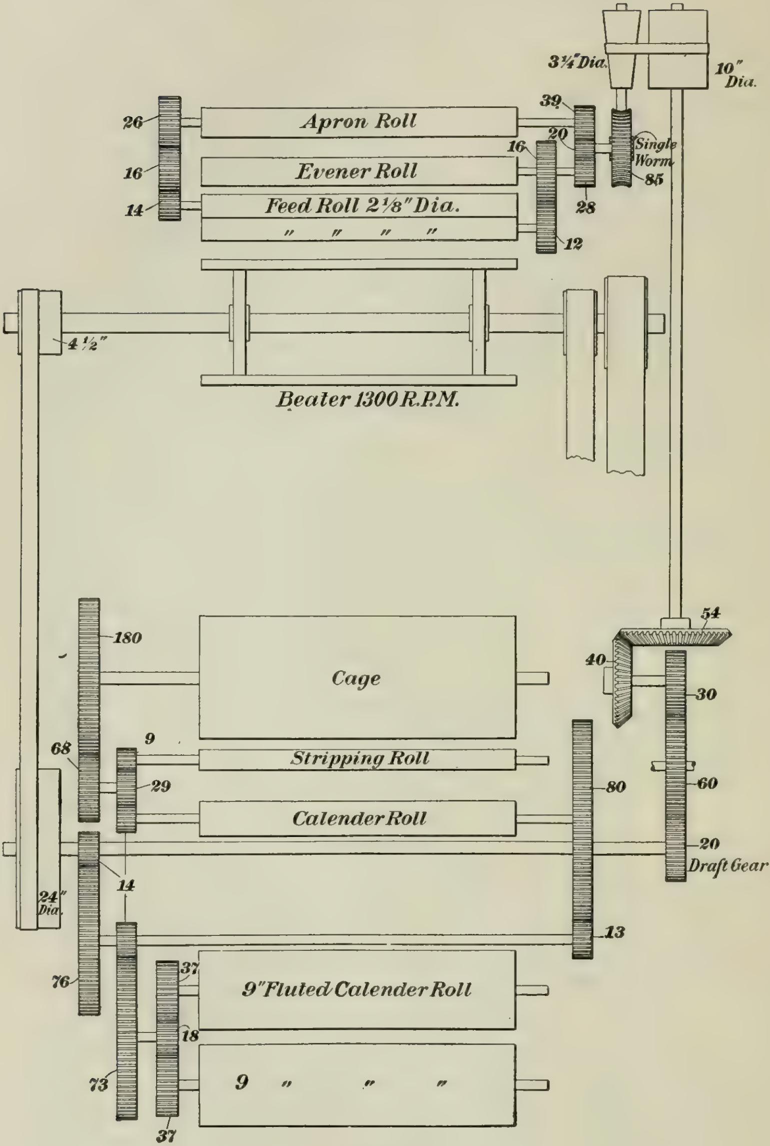

3¼" Dia.
10" Dia.
39
26
Apron Roll
20
16
Single Worm
16
Evener Roll
85
14
Feed Roll 2⅛" Dia.
28
" " " "
12
4½"
Beater 1300 R.P.M.
54
180
Cage
40
30
9
68
Stripping Roll
29
80
60
Calender Roll
20
Draft Gear
14
24" Dia.
13
37
76
9" Fluted Calender Roll
18
73
9 " " "
37

FIG. 28

length may be found by dividing the length of lap required by the constant. The constant is obtained as follows:

$$\frac{30 \times (1) \times 7 \times 3.1416}{21 \times 1 \times 36} = .8726, \text{ constant}$$

35. Draft of Intermediate and Finisher Pickers. The draft change gears are shown on both plans, Figs. 27 and 28. In the machine shown in Fig. 27, there are two change gears n_1, n_2 so that if the proper draft cannot be obtained by changing one gear, the other may be changed. The draft of an intermediate picker is usually about 4.25 and that of a finisher picker about 4.50, when there are 4 laps up at the back.

The total draft of the machine shown in Fig. 27, with a gear of 55 teeth on the lower-cone shaft meshing with a gear of 35 teeth, and with the belt in the center of the cones, is as follows:

$$\frac{9 \times 24 \times 12 \times 17 \times 18 \times 27 \times 55 \times 9 \times 78 \times 24}{24 \times 53 \times 96 \times 60 \times 27 \times 35 \times 9 \times 2 \times 12 \times 3} = 4.422, \text{ draft}$$

The total draft of the machine shown in Fig. 28, with a 20-draft gear and the belt in the center of the cones, is as follows:

$$\frac{9 \times 18 \times 14 \times 14 \times 30 \times 54 \times 3.25 \times 85 \times 28 \times 12}{37 \times 73 \times 76 \times 20 \times 40 \times 10 \times 1 \times 20 \times 16 \times 2\frac{1}{8}} = 4.275,$$
draft

CARE OF PICKERS

36. Regulation of Air-Current.—The air-current that draws the cotton to the cages should be regulated to draw the cotton to them in such proportions that the upper cage will receive an amount slightly in excess of that which the bottom one receives, since, if the stock is drawn to the cages in equal amounts, the sheet delivered at the front of the picker will be formed of two layers of practically the same thickness, and when run through the next machine, will be liable to split. Pickers are constructed with dampers in the flue so that the required adjustments may be made. The making of a good lap is an important point. It should be perfectly cylindrical when removed from the machine,

and should feel as firm at one point as at another. It should be built so that the layers will unroll easily at the next process without sticking together. This defect, which is known as **splitting**, or **licking**, is due to various causes; such as excessive fan speed, improper division of the air-currents, oil dropping on the cotton, etc.

If the air-current is stronger on one side than on the other, the side having the weaker current is usually soft. The velocity of the air-current is also responsible for the amount of waste removed. If the air-current is too strong, it prevents good cotton from being struck through the bars, but at the same time prevents all the dirt from being removed, since the current is strong enough to carry it forwards. On the other hand, if the current is so weak that the dirt drops readily, good cotton may also drop with it, causing excessive waste. A medium air-current must therefore be found that will allow the removal of the greatest amount of dirt with the least amount of cotton. The setting of the grid bars also aids in this, and the matter of keeping all the parts clean cannot receive too much attention. In some cases it is found necessary, in order to avoid an excessive amount of air entering through the grid bars and preventing the removal of the dirt, to admit air through the ends of the beater cover or through the casing that extends over the passage between the beater and the cages.

The laps delivered should be as near a uniform weight as possible. Each lap from the finisher picker is usually weighed, and a variation of $\frac{1}{2}$ pound in either direction is allowed; that is, if laps weighing 35 pounds are delivered when they are the correct weight per yard, any laps weighing between $34\frac{1}{2}$ and $35\frac{1}{2}$ pounds are allowed to pass. Laps weighing outside this range should be put back and run over again, and if too many of these laps are uniformly heavy or light, the regulating screw on the evener should be adjusted.

37. Causes of Uneven Laps.—When laps are found to be weighing unevenly, the fault may be at several places. The feeder may be feeding unevenly; the evener, either on

the intermediate or finisher lapper, may be out of order, possibly through not being cleaned and oiled properly or through using a stiff evener driving belt. This should be perfectly pliable and have good piecings. Cotton may also remain in the trunks or over the inclined cleaning bars because these are not kept clean.

Another cause for uneven laps is often found in the position of the cone belt on the cones of the evener motion. If, when the proper amount of cotton is passing through the picker, the cone belt is running at one end of the cones, it will not allow the belt to be shifted far enough toward the nearest end of the cones to correct any considerable variation requiring a movement of the belt in that direction. The different parts of the evener motion should be so adjusted that the belt will run at the center of the cones when the correct amount of cotton is passing through the machine. This will give the cone belt one-half of the cones to work on for regulating either light or heavy laps.

Below is given a table showing for what numbers of yarn certain weights of lap are generally used:

Numbers of Yarn	Weight of Lap per Yard From Finisher Picker Ounces
1s to 10s	14.0
10s to 20s	13.5
20s to 30s	13.0
30s to 40s	12.0
40s to 50s	11.5
50s to 60s	11.0
60s to 70s	11.0
70s to 80s	11.0
80s to 90s	10.0
90s to 100s	10.0
100s to 120s	9.5
120s to 150s	9.0

A good production for an intermediate or finisher picker is about 12,500 pounds per week, allowing from 6 to 10 hours for stoppages. A finisher picker for making 40-inch laps occupies a floor space of about 16 feet by 6 feet $8\frac{1}{2}$ inches and requires about 4 horsepower to drive it.

38. Cleaning and Oiling.—Pickers should be kept well cleaned and oiled. All oil holes, wherever possible, should be covered in order to keep grit and sand from the bearings. In oiling, care should be taken not to allow the oil to get on the inside of the casings where the cotton passes. The beater, grid bars, inclined cleaning bars, and cages should be picked clean of cotton daily and kept free from dirt and oil. All air passages and pipes from fans should be kept clean, but the covers of the doors of these air passages or pipes should not be removed while the machine is running.

COTTON CARDS

(PART 1)

INTRODUCTION

1. The lap of cotton as it leaves the picker consists of cotton fibers crossed in all directions, together with a small amount of foreign matter, consisting more especially of lighter impurities such as pieces of leaf, seed, or stalk, and thin membranes from the cotton boll. Such material is of too light a nature to be removed by the action of the beaters or to drop through between the grid or inclined cleaning bars of the pickers, so that it is carried forwards with the cotton and into the lap. In order to remove this foreign matter, machinery of an entirely different character from the cleaning machinery previously used must be adopted, and for this purpose the **cotton card** is employed, the process being known as **carding.** Carding is regarded by many manufacturers as one of the most important processes in cotton-yarn preparation. In addition to cleaning the cotton, it is also the first step in the series of attenuating processes, which gradually reduce the weight of cotton per unit of length sufficiently to form a thread. The lap from the picker is comparatively heavy, and must be reduced considerably in weight at various machines in order to give the weight per unit of length required in the yarn. The carding process is the one that follows the picking operations in all cotton mills, whether coarse or fine, and whether making carded or combed yarns.

2. Objects of Carding.—The objects of carding are: (1) The disentangling of the cotton fibers, or the separation

of the bunches, or tufts, of fiber into individual fibers, and the commencement of their parallelization; (2) the removal of the smaller and lighter impurities; (3) changing the formation of cotton from a lap to a *sliver*, accompanied by the reduction of the weight per yard of the material. A **sliver** is a round, loose strand of cotton without, or almost without, twist, and usually from 40 to 80 grains per yard in weight. It is generally coiled in a can, and is made at the carding, drawing, and combing processes.

3. Principles of Carding.—In order to arrive at the previously mentioned objects, the principle of combing the fibers between sets of closely arranged wire teeth is adopted; one set may be fixed and the other moving, or each set may be moving in the opposite direction to the other, or both may be moving in the same direction but at different speeds. In any case, the sets of wire teeth are in close proximity to one another. The first and second objects—the disentangling of the cotton fibers and the removal of the impurities—are attained by this means, as the fibers forming the small tufts are drawn apart and the lighter impurities are caught between the wires, where they remain until removed by special means. Use is also made of the centrifugal force of a cylinder covered with wire teeth and revolving at a high speed in attaining the first and second objects of carding; the ends of the fibers are thrown against stationary or moving points of wire and the fibers thus combed out, while heavier impurities such as sand, dirt, and dust are thrown out, owing to the high speed of the cylinder. Another method of arriving at the second object is that of arranging knives or bars partly around the revolving portions of the card, to clean and throw off the dirt, sand, and dust from the fibers as they are drawn past such obstructions. The third object is attained by adopting the principle of drafting, the attenuation of the material being produced by revolving cylinders covered with wire teeth, instead of by the usual method of rolls, which are used in this machine only at the feed and delivery.

Carding is really a combing or brushing action, the fibers being operated on by a series of wire teeth, which has the same effect as loosely holding a few fibers at a time and striking them with a comb; the process, however, must not be confused with that technically known as *combing*, which is an entirely separate process and used only in the manufacture of fine yarns. The machine employed in carding is usually spoken of as a *card*, or sometimes as a *carding engine;* this latter name, however, is used more commonly in England than in the United States.

CARD CONSTRUCTION

THE REVOLVING-TOP FLAT CARD

PRINCIPAL PARTS

4. The **card** that is most commonly used and now almost universally adopted for new cotton mills is known as the **revolving-top flat card,** sometimes spoken of as the *revolving flat card*, or the *English card*. Views of it are shown in Figs. 1 and 2, Fig. 1 showing one side of the card, with the machine in condition for operation, while Fig. 2 shows the other side as it is seen when stopped and without any stock passing through. A section through the same card from back to front is shown in Fig. 3. The various parts of the card are lettered the same in all three figures, and reference letters should be referred to on Fig. 3 especially; but it is also advisable to refer to Figs. 1 and 2 for the same parts, in order to identify them and ascertain their relations to one another. The same letters are used in other figures throughout this Section in accordance with the following list. All parts of a single motion or section of the card are designated by the same letter, which in some instances is followed by a figure, known as the *subscript*, to distinguish the particular part for which it is used from related parts having the same reference letter.

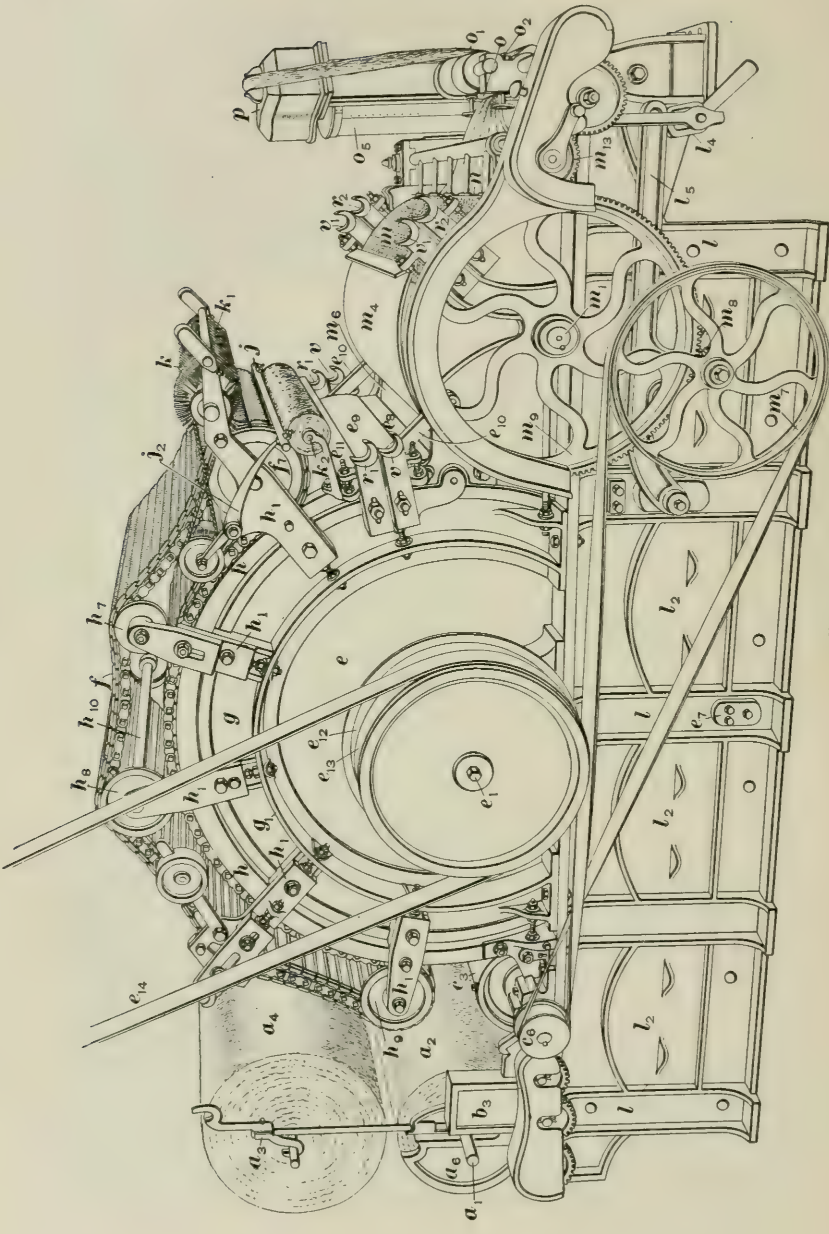

p
o1
o2
o
o5
m13
l4
l5
n
r2
v1
v2
m
l
m4
m6
m1
m8
k
k1
j
j2
r1
v
e10
e9
e11
k2
f1
e8
m9
m7
h1
h7
h10
f
g
e
e12
e13
e1
e7
l2
h8
g1
h
e14
a4
h9
a2
e3
e6
b3
a3
a6
a1

FIG. 1

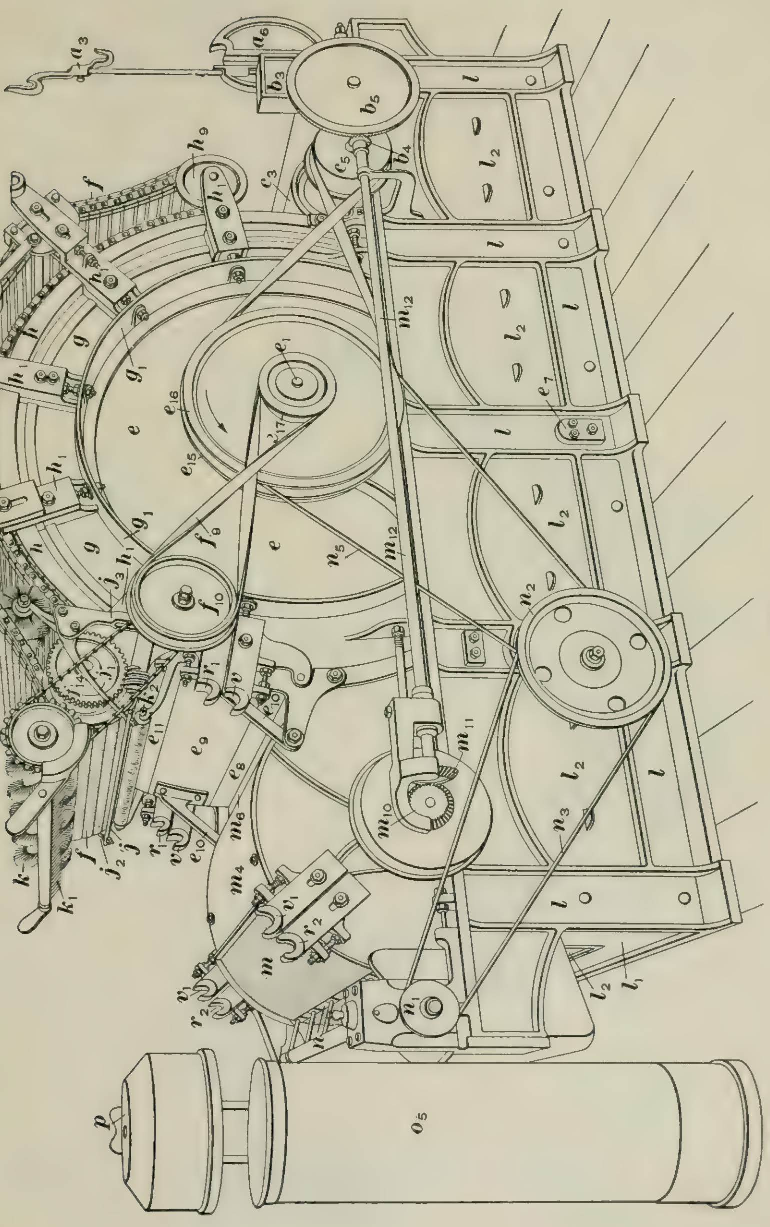

a_3
a_6
b_3
b_5
b_4
c_5
c_3
h_9
f
h_1
h
h_8
g
g_1
e_1
e
e_16
e_15
e_17
h_10
f_9
f_10
m_12
l
l_2
e_7
n_5
n_2
h_7
j_3
j_14
j_1
k_2
r_1
v
e_10
e_11
e_9
e_8
m_11
m_10
m_6
m_4
n_3
k
k_1
j_2
j
v_1
r_2
m
n_1
n
l_1
o_5
p

FIG. 2

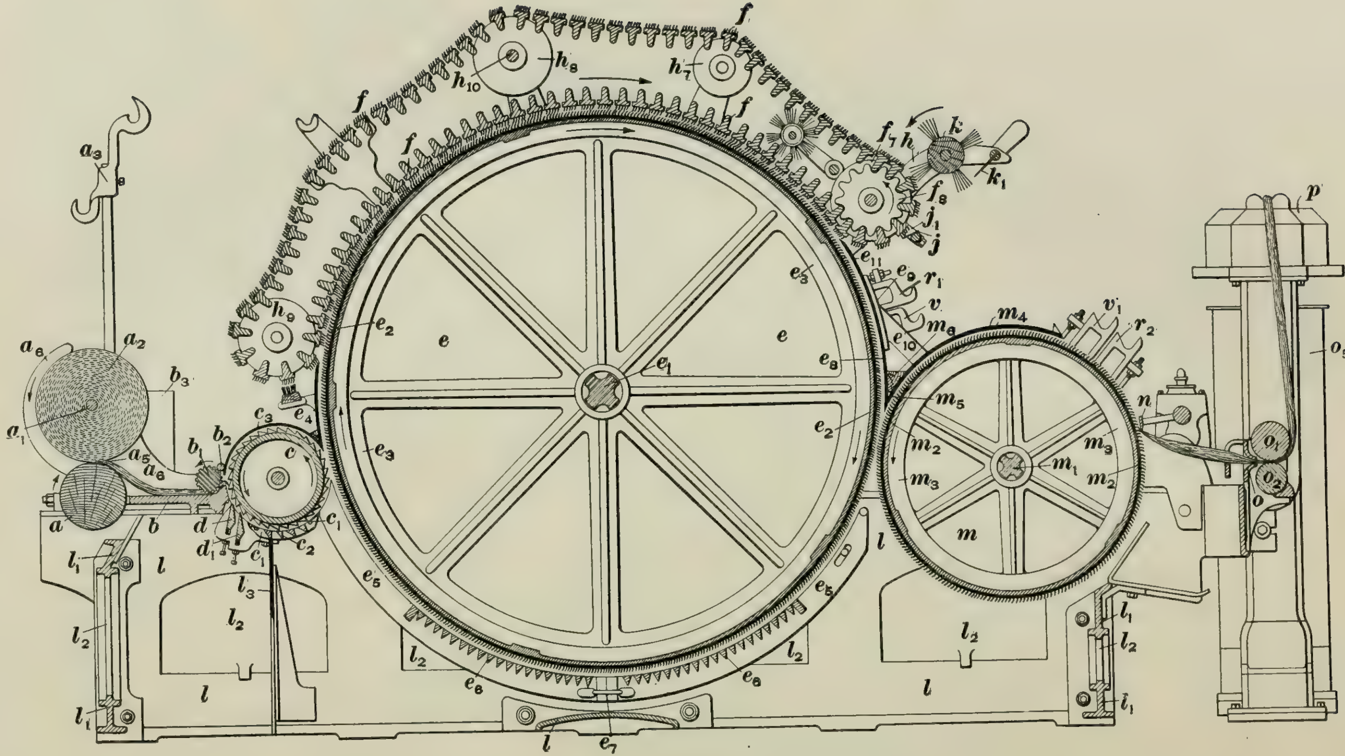


FIG. 3

5. The principal parts of the machine are as follows:

a, Lap roll.
a_2, Lap that is being carded.
a_4, Spare lap.
a_6, Lap plates.
b, Feed-plate.
b_1, Feed-roll.
b_3, Weights for feed-roll.
c, Licker.
c_1, Licker screen.
d, d_1, Mote knives.
e, Cylinder.
e_4, Back knife plate.
e_5, Cylinder screen.
e_8, Lower front plate.
e_9, Door at front of cylinder.
e_{11}, Front knife plate.
e_{12}, Tight pulley on cylinder.
e_{13}, Loose pulley on cylinder.
f, Flats.
g, Arches of card.
h, Flexible bend on which a portion of the flats rests.
h_7, h_8, h_9, Pulleys for supporting flats.
j, Flat-stripping comb.
k, Flat-stripping brush.
k_1, Hackle comb for cleaning flat stripping brush.
l, Card sides.
l_1, Cross-girts.
l_2, Doors in frame of card.
m, Doffer.
m_4, Doffer bonnet.
m_8, Barrow gear.
m_{12}, Side shaft.
n, Doffer comb.
o, Trumpet.
o_1, Top calender roll.
o_2, Bottom calender roll.
o_5, Can in which sliver is coiled.
p, Cover of coiler.
p_1, Coiler calender rolls.

Figs. 4 and 5 show a revolving flat card of another style of construction, but all essential parts are the same and are lettered as in Figs. 1, 2, and 3.

6. Feed-Roll and Feed-Plate.—At the back of the card in Fig. 1 is shown the lap a_2, which has a rod a_1 passed through its center and rests on the lap roll a, shown in Fig. 3. The lap a_2 is the one being carded, a spare lap a_4 being shown above it in Fig. 1, resting in a stand a_3. The lap roll a is constructed of wood and is either fluted or has a rough surface, sometimes produced by covering it with a coat of paint mixed with sand, in order to cause the lap to unroll by friction with the lap roll and without any slippage.

The cotton is drawn over the feed-plate b, Fig. 3, by the feed-roll b_1, the single layer, or sheet, leaving the lap at the

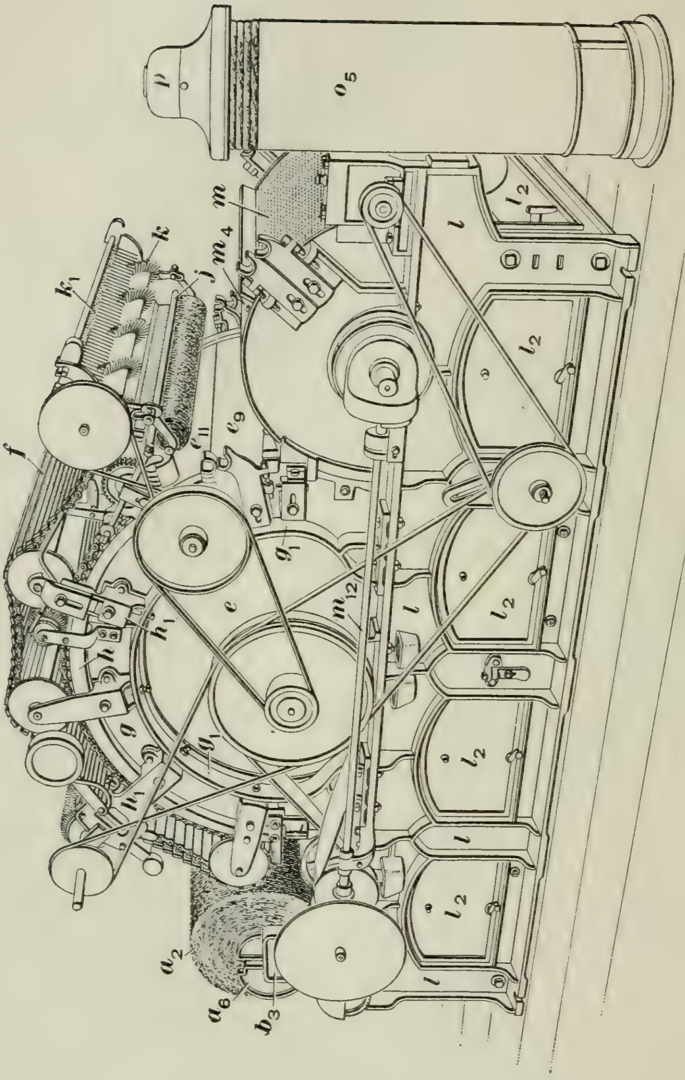


Fig. 4

point a_5. As it passes from the lap to the feed-roll, each outer edge of the sheet comes in contact with a lap guide—a wedge-shaped piece of metal bolted on the inside of the

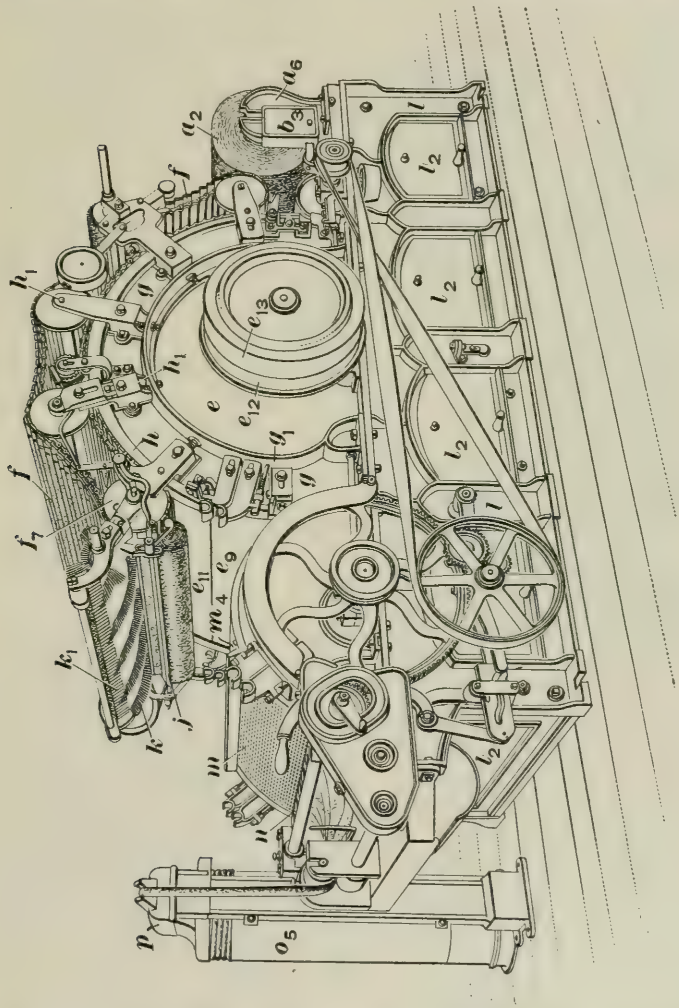


FIG. 5

plate a_6. This guide turns up the edges of the sheet to a small extent, making it slightly narrower as it approaches the feed-roll. This tends to prevent the outer edge of the

cotton from spreading and producing a ragged edge. The feed-plate b extends under the feed-roll b_1, with its nose projecting upwards in front of the feed-roll almost to the teeth shown on the circumference of the licker c. The feed-roll b_1, which revolves in the direction indicated by the arrow, is fluted longitudinally and is sufficiently large in diameter to resist any tendency to spring or bend when a thick piece of cotton passes beneath it. Its ends rest in slides and it is weighted at each end by means of a weight b_3, Figs. 1 and 2, on a lever that has, as a fulcrum, a lug on the feed-plate. The lever has a bearing on a bushing on the feed-roll and thus produces the pressure of the feed-roll on the sheet of cotton on the feed-plate, the extent of which may be regulated by moving the weight b_3 along the lever. If the pressure is too light, the action of the licker will pull the cotton from the feed-roll before it should be delivered. This is known as *plucking*, and results in cotton being taken by the licker in large and tangled flakes that have not been opened, thus causing uneven work and requiring the finer parts of the card to perform the heavy work, which should be done by the licker.

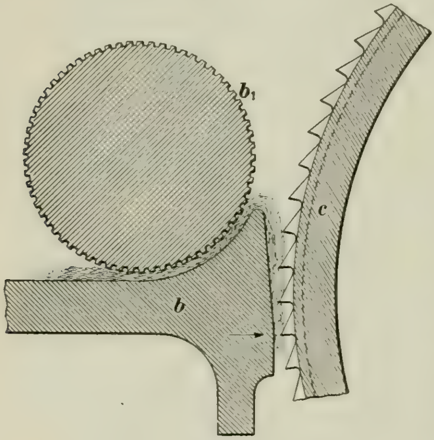


FIG. 6

Above the feed-roll rests a small iron rod b_2 that is revolved by frictional contact with this roll and, since it is covered with flannel, collects any fiber or dirt that may be carried upwards over the surface of the feed-roll and thus acts as a clearer. It also serves to prevent any air-current from passing between the feed-roll and the licker cover.

The lap roll a is positively geared with the feed-roll b_1 in such a manner that the feed-roll takes up exactly the amount

of cotton delivered by the lap roll, without any strain or sagging, and as it revolves, carries this cotton over the nose of the feed-plate so that a fringe is brought under the action of the licker *c* in the manner shown in Fig. 3, and on a larger scale in Figs. 6, 7, 8, and 12. The upper end of the nose of the feed-plate is rounded so as not to damage the cotton resting on it and pressed against it by the action of the licker.

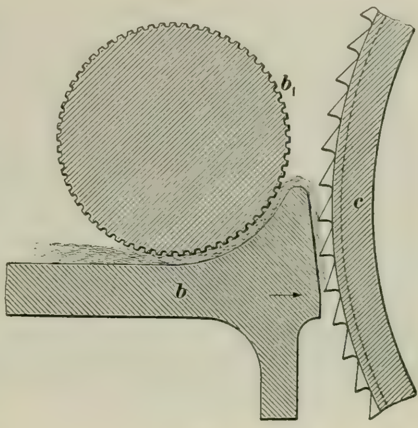


FIG. 7

7. The important difference in various feed-plates is in the distance from the bite of the feed-roll to the lower end of the face, indicated by the arrow in Figs. 6, 7, and 8. By regulating this distance in accordance with the length of staple being worked, the entire length of staple is so supported that it receives the full benefit of the cleaning and disentangling action of the licker, which reduces the work on the finer parts of the card. The distance between the bite of the feed-roll and the lower edge of the face of the feed-plate should be from $\frac{1}{16}$ to $\frac{1}{8}$ inch longer than the average length of the cotton being worked, as it is necessary that the fibers should be free from the bite of the feed-roll before the action of the teeth of the licker exerts its greatest pull, which

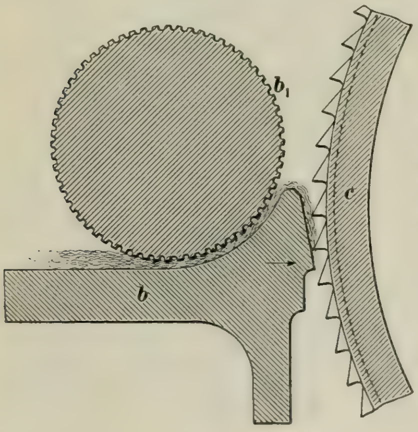


FIG. 8

is at the lower edge of the plate; otherwise, the fibers would be broken. The fringe of cotton is shown in Fig. 9. The feed-plate shown in Fig. 6 is suitable for sea-island cotton, as it has a face that makes it possible for the long fibers to hang down; the feed-plate shown in Fig. 7 is the style commonly used in America, being adapted for the various grades of American and Egyptian cottons. A feed-plate with a shorter face, as shown in Fig. 8, is sometimes made for very short-stapled cottons, such as those grown in India and China.

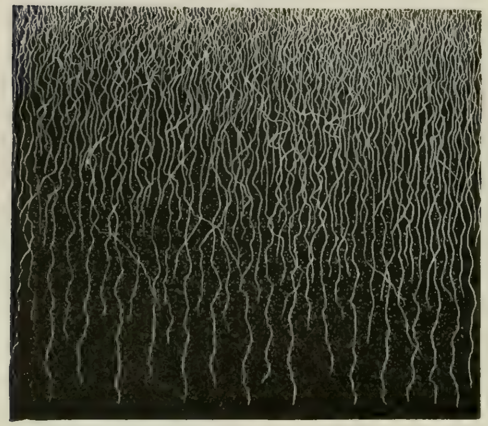


Fig. 9

8. Two-Roll Method of Feeding.—Some cards, instead of having the feed-roll and feed-plate, are constructed so as to feed the licker by means of two feed-rolls, as shown in Fig. 10. This is an older form of feeding and is not so desirable. The disadvantage of this method is that a fourth of the diameter of the lower feed-roll is covered with loose cotton before it reaches the point where it comes under the action of the teeth of the licker, thus tending to increase the possibility

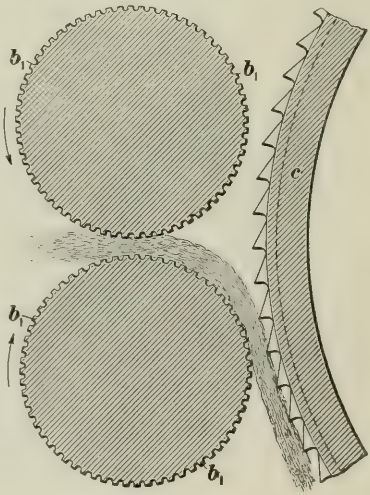


Fig. 10

of the licker plucking large tufts of cotton before the cotton ought to be delivered. This system is also inferior on account of the brief opportunity given for the licker to operate on the fringe of cotton, as compared with the roll and feed-plate system, where a long fringe of cotton is presented to the licker, thus giving a much better opportunity for combing and removing the dirt. In fact, the combed fringe of cotton in a card using the feed-plate can be arranged to be about three times the length of that in a card using the two-roll method of feeding.

9. Licker.—The object of either of these feeds is to feed a regular supply of cotton to the licker *c*, shown in

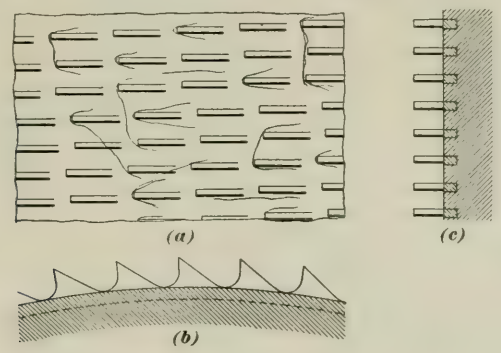


FIG. 11

Fig. 3, sometimes called the *leader*, *taker-in*, or *licker-in*. The **licker** consists of a hollow metal roll about 9 inches in diameter. On the outside of the shell, or curved part, of the roll, and extending from one end to the other, are spiral grooves into which rows of teeth are inserted. Fig. 11 (*a*) is a view of the teeth of the licker as they appear when looked at from above, and also shows the fibers being carried by them from the feed-roll, thus indicating the manner in which the lap of cotton is separated almost into individual fibers by the operation of the licker, which revolves so rapidly, compared with the amount of cotton delivered, that about 2,000,000 teeth pass the nose of the feed-plate while 1 inch of cotton is being delivered. It will be

seen from Fig. 11 (*a*) that the teeth are scattered, or *staggered*, over the shell of the roll in consequence of the spiral arrangement, and thus one tooth does not strike the fringe of cotton exactly where the previous one struck.

Fig. 11 (*c*) is a section of a portion of a licker showing the construction of the wire from which the teeth are formed, and also the method of fastening it securely in the roll. The teeth are punched out of a narrow, flat, strip of steel, or wire, carrying a thickened rib along one edge. This rib is forced into the grooves prepared in the shell of the licker, and the teeth project, as shown in Fig. 11 (*b*), the dotted line indicating the depth to which the rib is sunk into the shell of the licker. Several separate spirals are laid side by side, the distance between two rounds of any one spiral being 1 inch, and there are either five, six, seven, eight, nine, or ten spirals side by side, according to the class of work for which the card is intended. This results in the distance between the centers of two consecutive spirals being either $\frac{1}{5}$, $\frac{1}{6}$, $\frac{1}{7}$, $\frac{1}{8}$, $\frac{1}{9}$, or $\frac{1}{10}$ inch apart, while the points of the teeth are usually $\frac{1}{4}$ inch apart lengthwise of the wire.

The shell of the licker *c* is shown in section in Figs. 3 and 12, which also show the relative position of the licker to the contiguous portions of the card. Below the feed-roll b_1, clearer b_2, and feed-plate *b* are seen the sections of two knives d, d_1, which are known as **mote knives.** These knives extend across the card in the position shown, with the blade of the knife near the teeth of the licker; their object is to remove such impurities as hulls, husks, bearded motes, etc., or in other words, all portions of matter other than cotton.

At the nose of the feed-plate, the licker is moving in a downward direction and the teeth are pointing in the direction of its revolution. Since the fringe of cotton is held by the roll, it will be disentangled as the teeth pass through it. When the cotton is released from the bite of the feed-roll, it will be taken by the teeth of the licker. Any short fibers, however, that are not sufficiently long to be secured by the licker, will fall through the space between the mote knives.

The cotton that drops in this manner is known as **fly**, and its loss is beneficial since it leaves the cotton that passes forwards in a more uniform condition as regards its length of staple. The licker has a surface speed of about 1,000 feet per minute, and thus, as it revolves with the cotton, the portions of the fibers that are not in contact with the teeth will be thrown out by centrifugal force, so that the impurities that project from the fibers on the surface of the licker will

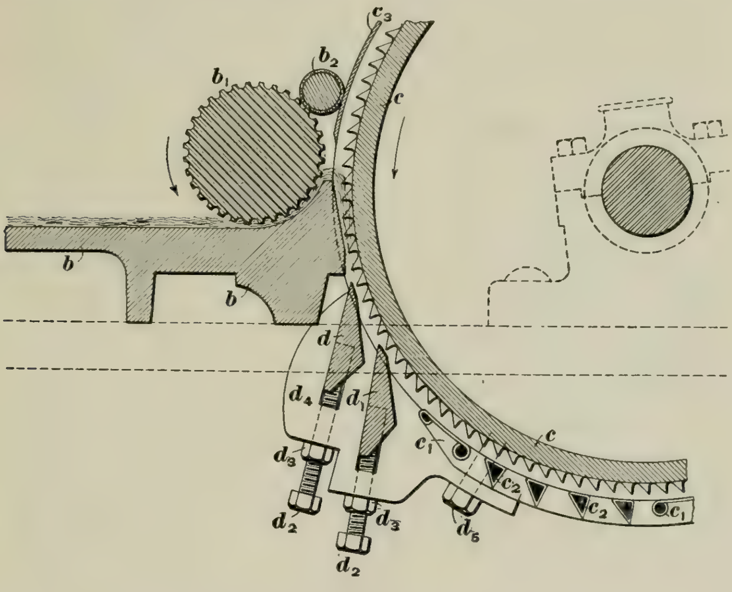


Fig. 12

come in contact with the blades of the mote knives and be removed, dropping into the cavity below the knives.

In the usual construction of cards there are two of these mote knives, although one may be used. The knives are rigidly held in suitable supports, and in the style under consideration their correct angle is decided by the machine builder, the arrangement being such that this angle cannot be changed. They are sometimes, however, made adjustable, either by being placed in a swinging frame or, as in Fig. 12, by being provided with setscrews d_2 and locknuts d_3, by

means of which either knife may be moved closer to or farther from the licker and then locked in position; or the entire bracket d_4 that carries both knives, may be moved farther from or closer to the feed-plate by loosening the screw d_5, sliding the entire bracket d_4 on the frame of the licker screen, and then relocking it.

10. Licker Screen and Licker Cover.—Underneath the licker is a casing c_1 known as the **licker screen.** This casing, which is shown in Figs. 3 and 12, is made of tin and extends across the card. The portion of the screen directly under the licker is composed of transverse bars c_2, triangular in shape with rounded corners and set with their bases inverted, the remainder of the screen being plain metal. As the licker revolves, whatever heavy impurities were not previously taken out will be thrown through the openings in the screen, due to the action of centrifugal force. The cotton will also come in contact with the screen as it did with the mote knives, and thus additional impurities will be removed.

The top of the licker is protected by a metal cover c_3 known as the **licker cover,** or **bonnet,** which is curved to correspond to the curved surface of the licker. This cover is held in position by two disks, one at each end, through which the shaft of the licker projects. These disks are held in position by flanges attached to them, which rest in the licker bearings attached to the framework of the card. The licker cover is screwed to these disks, and thus the licker is completely enclosed. The points where the shaft passes through the disks should be kept clean and well oiled; otherwise, the points of contact will become heated and tend to bind the shaft.

11. Card Cylinders.—Situated about midway between the back and front of the card, and a prominent feature in its construction, is the cylinder e, mounted on the shaft e_1. This cylinder is usually 50 inches in diameter, while its width depends on the width of the card, being usually 36, 40, or 45 inches. Formerly card cylinders were made of wood, but it is now the universal practice to construct them of cast iron,

as metal resists the changes of temperature and humidity better than wood, which is liable to warp and twist and thus prevent accurate setting of the card. When metal cylinders were first used, the shell e_2, Fig. 3, was constructed in two pieces, which were bolted together, but the best and most modern method is to make the shell in one casting, with a sufficient number of longitudinal and sectional ribs on the interior of the shell to make it strong and rigid. This shell is mounted at each end on a spider e_3, which consists of a heavy rim cast in one piece with a series of strong supporting arms. The hubs of the spiders are accurately bored for the reception of the shaft of the cylinder, while the rims are turned to a true shape and size and accurately fitted to the ends of the shell.

The cylinder should be mounted on its shaft as rigidly as possible, to avoid the possibility of its becoming loose. The method adopted in the card under consideration is as follows: A shaft long enough to pass through the shell and project sufficiently beyond to rest in the bearings and also carry the necessary pulleys for driving the cylinder and various parts of the card is forced into its position through the hub of each of the spiders by means of a powerful screw press. It is then secured to the spiders by means of two large taper dowels, one at each end of the cylinder. These dowels are driven into holes drilled through the hubs of the spiders and through the shaft.

The complete cylinder should be turned and afterwards ground while resting on its own bearing, not on a mandrel, so as to produce an absolutely true surface when in operation. As these cylinders are intended to run at a high speed, they are also balanced so as to insure even running, and when their construction is complete the ends are cased in with sheet iron to prevent dust or fiber from entering the cylinder and to avoid accidents that would be liable to result if they were rotated at a high speed with uncovered arms. In Figs. 1 and 2, the letter e applies more directly to these end casings, although it is used to indicate the cylinder as a whole.

The surface of this cylinder is covered with card clothing, which is a fabric with teeth embedded in it and projecting through it at an angle. The addition of the clothing to the cylinder increases its diameter to about $50\frac{3}{4}$ inches. Reference to Fig. 3 shows the teeth on the surface of this cylinder pointing in the direction of its motion, as indicated by the arrow shown on the shell of the cylinder. A point on the surface of the cylinder travels about 2,150 feet per minute. The teeth of the wire are set very closely in the fabric, there being about 72,000 points to the square foot and more than 3,000,000 points on the entire cylinder. A fuller description of this clothing, together with the manner in which it is applied, is given later.

12. The description of the licker and its operation on the cotton has been carried far enough to explain how the heavier impurities are removed from the fringe of cotton projecting over the feed-plate and driven downwards into the space beneath the card, and also how the fibers are removed from this fringe when they project downwards sufficiently to be released and are carried along on the ends of the teeth of the licker at a speed of about 1,000 feet per minute. These fibers are now transferred to the surface of the cylinder, which is rendered possible by the respective directions of motion of the cylinder and licker and by the direction in which their teeth are pointing. At the point where the licker and the cylinder almost come in contact, both are moving in the same direction and have their teeth pointing upwards. The teeth on the licker are comparatively coarsely set, while those on the cylinder are finely set and have a much greater tendency to hold and to retain the minute fibers than the teeth of the licker. The cylinder is also revolving at more than double the surface speed of the licker, and consequently the fibers are swept off the surface of the licker where the surfaces of the licker and cylinder are in closest proximity and carried upwards on the surface of the cylinder.

Fig. 13 shows the relative positions and the respective styles of construction of the licker and the cylinder at the

point where they approach each other, while Fig. 14 shows an enlarged view of the teeth.

In Figs. 3 and 13, a metal plate designated as a *cover* is shown in connection with the licker cover. This cover e_4, which is known as the **back knife plate,** protects the cylinder at this point and prevents an air-current from being formed by the motion of the cylinder. A wedge-shaped piece of wood c_4 covered with flannel is usually placed in the receptacle formed by the junction of the licker cover with the back knife plate, in order to prevent any possible chance of an air-current.

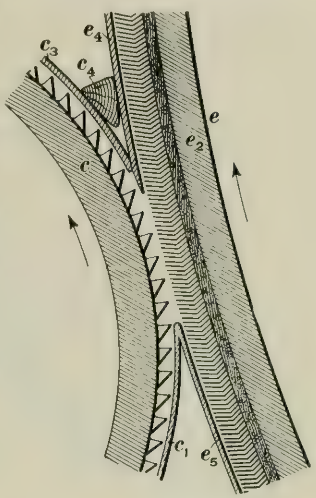


FIG. 13

13. Flats.—Above the cylinder and partly surrounding its upper portion is a chain of flats f, as shown in Figs. 1, 2, and 3. These are the parts that give the name *revolving-top flat card* to the card. They are made of cast iron, approximately **T**-shaped in section, and are partly covered with card clothing about $\frac{15}{16}$ inch wide. They are usually $1\frac{1}{8}$ inches wide and slightly longer than the width of the cylinder, but are covered with clothing only over the portion of their length that corresponds to the width of the cylinder. This clothing is of a finer wire, with the teeth more

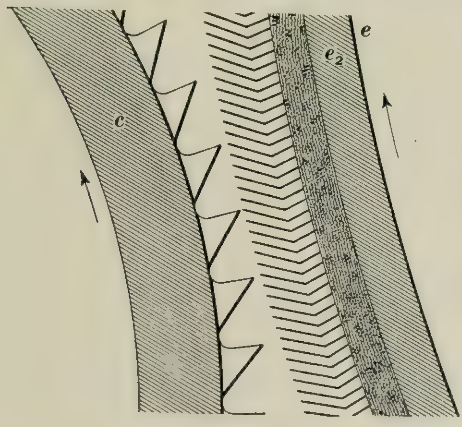


FIG. 14

closely set, than that on the cylinder, and is usually fastened to the flat by clips on each side of the flat. There are from 104 to 110 flats on a card, but as they are in proximity to the cylinder for only about one-third of its circumference, only from 39 to 43 flats are presented to the cylinder at one time. Fig. 15 (*a*) gives an end view of a flat, while (*b*) shows a section. Each end is drilled and tapped to receive a set-screw, which passes through a hollow stud carrying links, and as each link extends from one flat to the next and each end of each link encircles one of these hollow studs, the flats are connected in an endless chain. The screw that is inserted is of special construction, right-hand screws being used on one side of the card and left-hand screws on the other, so that the motion of the flats will tend to tighten rather than to loosen the screws and thus avoid the possibility of their becoming loose and allowing a flat to come in contact with the cylinder, which would cause considerable damage.

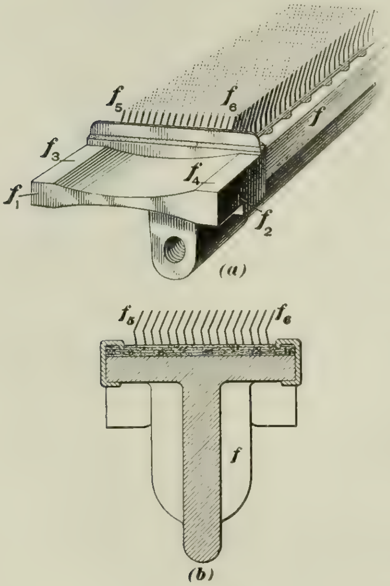


FIG. 15

The flats must be so arranged that they will be supported immediately above the cylinder without coming in contact with it or without their supports interfering with its rotation. This is done by means of two arches *g*, Figs. 1 and 2, which are strongly constructed castings resting on the framework of the card, one on each side, and securely bolted to it. Each arch carries five brackets h_1, which are composed of several pieces. One portion of each bracket projects upwards sufficiently to carry a pulley that serves as a support for those

flats that are not performing any carding action and that are passing backwards over the cylinder, while another portion of each bracket serves as a support for the flexible bend *h* and provides a ready means of adjusting it in order to move the wire teeth of the flats that are at work nearer to or farther from the wire teeth on the surface of the cylinder. A fuller description of the arrangements for adjusting the flexible bends will be given in the description of setting cards; it is sufficient to state here that the flexible bends can be moved farther from, or nearer to, the cylinder shaft at any one of five setting points on either side of the card, and by this means the upper edges of the bends can be adjusted so as to be practically concentric with the circumference, or wire surface, of the cylinder.

About forty of the flats rest on the flexible bend at each side of the card; the portions that are in contact with the bends are the two surfaces f_3 and f_4, Figs. 15 and 16. The chains are placed as near the flexible bends as possible, since if they are too far away, the pull and weight of the chains will cause a deflection in the flat. It is absolutely necessary that the chains on each side shall be exactly alike and work with the same tension, as the smallest variation will pull the flats out of their proper positions over the cylinder, and their accuracy will thus be destroyed. Chains are now so made that the whole variation from the standard is not more than $\frac{1}{50}$ inch. The flats are, of course, linked together on each side of the card by an exactly similar arrangement, except that, as has been previously stated, left-hand screws are used on one side and right-hand screws on the other.

14. Another representation of flats at work is given in Fig. 16, which shows them resting on the flexible bend, and held so that the points of the wire on their surfaces are almost touching the points of the wire on the cylinder. The exact distance between the wire on the flats and that on the cylinder is adjustable, and is usually about $\frac{10}{1000}$ inch. The distance between the wires, however, is not the same at each point in the width of the flat, as will be seen by referring

to Fig. 16. The wire of the flat at the point f_5 is closer to the cylinder than at the point f_6 in each case. The end view of the flat in Fig. 15 (*a*) shows that the metal composing the flat end is cut away more on the side f_1 than on the side f_2; consequently, when this flat is turned over and rests on the flexible bend, the side f_1 will drop closer to the cylinder than the side f_2, and the wires on the side f_5 will drop lower than the wires on the side f_6, thus making a slightly wedge-shaped space between the wires of the flat and the wires of the cylinder. The side f_5 of the flat, which is nearer to the cylinder, is known as the **heel**, while the side that is farther from the cylinder, namely, f_6, is known as the **toe**. Flats are always constructed with this heel-and-toe formation, and it should be preserved throughout the life of the card.

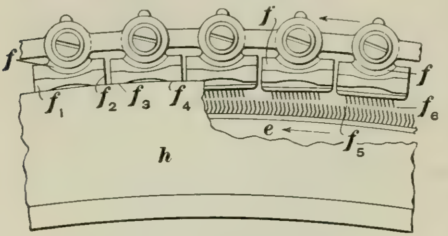


Fig. 16

The chain of flats is not stationary, but moves at a very slow speed, those flats nearest the cylinder moving toward the front of the card, while of course, the flats that are not working are carried backwards over the top of those that are at work. The means of imparting motion to the flats, which will be described in connection with the gearing of the card, results in a steady, smooth movement usually at the rate of about 3 inches per minute, although this may be changed to either a faster or slower speed, according to whether it is desired to remove more or less waste, respectively, from the cotton. The object of giving a movement to the flats is to carry toward the front of the card those flats that have become filled with impurities, so that they may be stripped and brushed out before they become too full of leaf and other foreign matter to perform the duty of carding the cotton.

15. The method of supporting the flats that are not at work is shown in Figs. 1, 2, and 3. They are supported at

the front by two pulleys f_7, one at each end of a shaft that has its bearings in two brackets, one on each side of the card. On the same shaft with these two pulleys are two sprocket gears, the one shown being marked f_8, the teeth of which mesh with the ribs on the back of the flats, and as this shaft is driven by means of worms and worm-gears, the sprocket gears drive the flats. The portion of the chain of flats directly above the cylinder and resting on the flexible bends revolves in the same direction as the cylinder, namely, toward the front. The flats that are not at work move backwards, in the opposite direction to the cylinder, and rest on pulleys h_7, h_8, h_9 supported by brackets h_1 attached to the arch of the card and duplicated on each side. The ends of the flats rest on these pulleys and impart motion to them by frictional contact. Two of these pulleys h_8 at about the center of the card are connected by a shaft h_{10} that extends across the card. The pulleys h_9, which are directly over the licker, form the turning point of the flats. Those that have been cleaned and carried along over the top turn and pass over the cylinder to perform their work, while those that have just finished their work, being charged with impurities, pass around the pulleys at the front and are cleaned. The bracket h_1, which supports the pulley h_8, is so constructed that the pulley may be raised or lowered to take out the sag, or slack, in the chain of flats or to allow sufficient slack for the flats to revolve freely.

16. As previously explained, the cotton is transferred to the face of the cylinder from the licker at the point where the two surfaces nearly touch each other, and is carried upwards and forwards by it until brought to the point where the flats and cylinder are brought into close proximity. When the cylinder reaches the first flat, the cotton on its surface has a tendency to project from it on account of the centrifugal force of the cylinder, and comes in contact with the teeth at the toe of the first flat. The stock is gradually drawn through the teeth of the flat, receiving more and more of a combing or carding action, until the heel of the flat is

reached, where the teeth of the flat and the cylinder are in the closest proximity, and where the cotton consequently receives the greatest carding action.

Some of the fibers that have not projected sufficiently may not have received any carding action, and the cylinder carries them forwards to the next flat. Those fibers that have been carded once may be carded again, with such additional fibers as are brought under the action of the succeeding flat, and so on throughout the entire series. The flats are set a little closer to the cylinder at the front, or delivery end, than at the back, or feed, end, of the card, and this method combined with the heel-and-toe arrangement of the flat insures a gradual and effective carding of all the fibers before they have passed under the last flat. The small impurities are left behind, since they are forced between the teeth of the wire on the flats or cylinder and remain there until the wire is cleaned, or stripped, as will be explained later. Thus the short fibers and impurities are retained, while the long, clean fibers are passed forwards.

17. Flat-Stripping Combs.—At the front of the card in Figs. 1, 2, and 3 is shown a comb j supported by two arms j_1, j_2. This comb consists of a thin sheet of steel attached to a shaft and having its lower edge made up of fine teeth. It is capable of adjustment so as to be moved closer to, or farther from, the wire on the flats. The comb is given an oscillating motion by means of a cam acting on the arm j_3, Fig. 2, and at each stroke strips from a flat a portion of the short fiber, leaf, and other impurities that adhere to its face. With the arrangement shown in Figs. 1 and 2, a close setting between the comb and flats is not possible owing to the difficulty in giving a backward movement to the comb without damaging the clothing of the flats.

Fig. 17 (*a*) represents a method of actuating the comb j that differs somewhat from that adopted on the card shown in Figs. 1 and 2. Fig. 17 (*b*) is a front view of the comb j with bearing j_5 and actuating lever j_8. This comb has two motions; namely, an oscillating motion, which it receives

through the arm j_3 from the cam j_4, by letting the arm j_1 swing around the point j_7 as a fulcrum, and a turning motion in its bearings j_5, received through the lever j_8 from the cam j_6. The teeth of the flats f are stripped while they are pointing downwards by a downward stroke of the comb, governed by the cam j_4. As the comb lifts, it is traveling in a direction opposite to that in which the teeth are pointing, and to prevent injury to the wire the comb is turned away

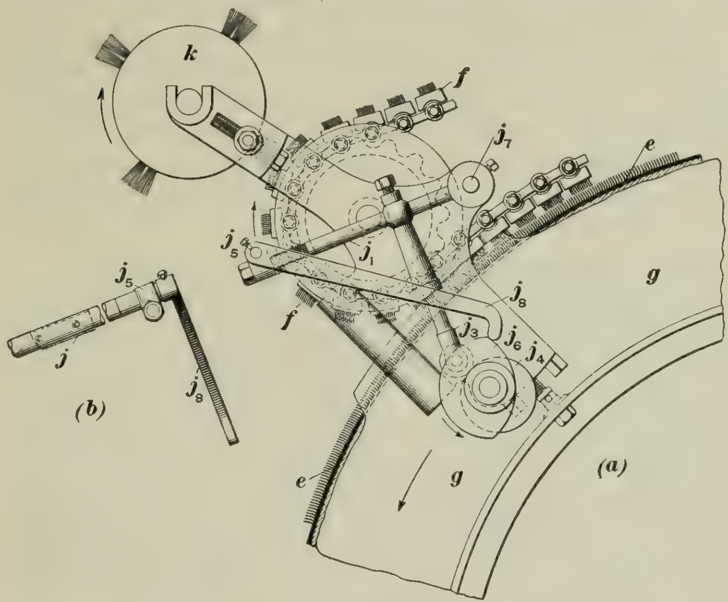


FIG. 17

from the flats by means of the cam j_6. By the use of this arrangement, a closer stripping action is obtained without damaging the wire.

18. Brush.—After the waste, known as *flat strippings*, has been removed by the comb j, the flats are brushed out by means of the brush k, shown in Fig. 17 (a) and also in Figs. 1, 2, and 3. This brush consists of a wooden barrel around the surface of which bristles are inserted in four spiral coils, the bristles being long, for a short distance at each end

in order to brush the ends of the flats, and shorter in the middle so as to just reach into the wire of the flat clothing. It is possible to adjust the position of this revolving brush so as to remove from the flats any impurities that were not taken out by the comb. The brush after it has operated on the flats is cleaned by means of a hackle comb k_1, Figs. 1, 2, and 3, the teeth of which project into the bristles of the brush and remove impurities. The hackle comb is periodically cleaned by hand. The flat strippings are either allowed to fall from the stripping comb on the steel covers m_4, e_8 or are collected on a round rod k_2, Fig. 1, which is suspended directly below the comb and rotated by frictional contact with the flats, thus collecting the strippings as they fall from the flats. These strippings, whether allowed to drop on the steel cover or wound on the surface of the rod, are removed periodically by hand.

19. Cylinder Screen.—Beneath the cylinder is placed a screen e_5, Fig. 3, known as the **cylinder screen.** This consists of circular frames on each side of the card, practically corresponding to the curvature of the cylinder and connected by triangular cross-bars e_6. As shown, the cylinder screen is constructed in halves, which are held together at e_7. It is so supported that it may be set closer to, or farther from, the cylinder, while at the same time it retains practically the same curvature as the cylinder. As the cylinder revolves, the fibers that project come in contact with the screens, and thus the dirt and other foreign substances will be struck off or thrown through the openings in the screens, and cannot be drawn back. The screens also aid in preventing the good cotton from leaving the cylinder. A screen of a similar character was mentioned as being placed below the licker; the licker screens and cylinder screens are usually connected so as to form one complete adjustable undercasing beneath both licker and cylinder.

20. Card Frame.—The entire mechanism thus far described is supported on the framework of the card. This consists of two strong and solid card sides l, which are

connected by cross-girts l_1 with the ends accurately milled and securely bolted to the card sides, thus forming a large rectangular frame. To this is attached a partition l_3, Fig. 3, that separates the dirt and fly produced by the mote knives from the licker and cylinder fly. In the card under description, this partition only projects downwards for half the distance between the licker screen and the floor. In some styles, however, the partition extends down to the floor and has a door in the center so that access can be obtained to the rear of the cylinder screen and space below. Around the framework of the card are doors l_2 that can be removed for the purpose of removing fly, setting undercasings, or examining the under parts of the card. There are four of these doors on each side of the card in addition to one at the front and one at the back.

21. Doffer.—Directly in front of the cylinder, in Figs. 1, 2, and 3, is seen the doffer m, which is supported by the doffer shaft m_1 and is constructed on the same principle as the cylinder. It consists of a perfectly rigid cylindrical shell m_2 carried at each end on a spider m_3 with six arms, to which it is firmly secured, the whole being rigidly attached to the doffer shaft. The doffer is covered with card clothing in a similar manner to the cylinder, except that the wire on the doffer is more closely set and somewhat finer. The doffer is the same width as the cylinder, but is of a much smaller diameter usually about 24 inches, but sometimes 27 inches. A large doffer is to be preferred, since it gives the same production with a lower speed or a larger surface speed with the same number of revolutions, and also gives the cylinder a better chance to deliver the fibers on account of its presenting a larger wire surface, although the advantage is not very great in either case. The doffer revolves in the opposite direction to that of the cylinder, the respective direction of motion at the place where they most nearly approach one another being shown by arrows in Fig. 3. At this place also the teeth of the cylinder and doffer point in opposite directions. As the teeth of the cylinder point in the direction in

which it moves and were pointing upwards at the place where they took the cotton from the licker, they consequently point downwards at the front of the card, while the teeth of the doffer at this place point upwards. The surface speed of the doffer, which varies from 44 to 107 feet per minute, is much less than that of the cylinder. As the cylinder approaches the doffer its surface is covered with separated fibers of cotton. Since it is set within about .005 inch from the doffer and the doffer is revolving so much more slowly, the fibers of cotton are deposited by the cylinder on the face of the doffer. They are condensed considerably from their arrangement on the surface of the cylinder because while spread over from 20 to 40 inches on the surface of the cylinder, they are laid in the space of about 1 inch on the surface of the doffer. The amount of this condensation varies according to the relative speed of the cylinder and doffer.

It does not necessarily follow that all the fibers are taken from the cylinder by the doffer the first time the cotton passes the point where the transfer is made, as they may not be in the proper position to become attached to the doffer. In this case, they may be carried around by the cylinder a second time and be more effectively carded. The doffer may be considered as merely a convenient means of removing the fiber from the cylinder. It is not intended to have any cleaning action, as the cleaning on the card is practically completed when the cotton has passed the flats, but as a matter of fact, it does remove some short fiber and light impurities that adhere within the interstices of the wire.

There is no screen beneath the doffer, as it is unnecessary, but placed above it is a protection consisting of a metal cover m_4 known as the **doffer bonnet** and shown in Figs. 1, 2, and 3, while another view is given in Fig. 18. This metal cover extends over the upper surface of the doffer, protects it from injury, and forms a portion of a receptacle to hold flat strippings in case no other method of gathering them is provided. At the point m_5 it extends to, and is almost in contact with, a plate of steel e_8 placed over the front part of the cylinder that performs the same duty

for the cylinder; namely, protecting it from damage and forming a part of the receptacle for the flat strippings. This plate e_8 extends upwards until a loose portion e_9 is reached, which forms a door, the position of which, when closed, is shown in Fig. 18 in dotted lines. This door swings on arms e_{10} so constructed that it can be thrown forwards and rest on the doffer bonnet; it is shown in this position in Fig. 18. Immediately above the space formed by the opening of this door is another plate e_{11}, which extends from the

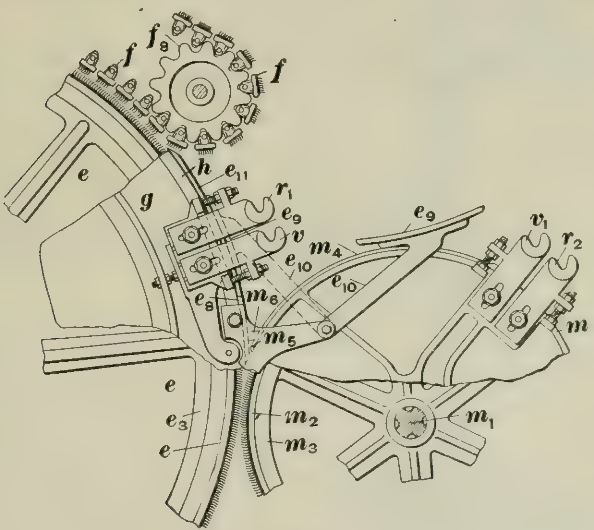


FIG. 18

door up into the space between the flats and the cylinder, almost in contact with both of them. This plate e_{11} is known as the **front knife plate.** It is also the object of these covers, or plates, mentioned in connection with the cylinder, doffer, and licker, to guard against accidents to the operatives, the licker being especially dangerous.

A draft strip, or making-up piece, m_6 is usually placed in the recess formed by the doffer bonnet and the plate e_8, so as to fit the angle between the doffer and the cylinder and thus prevent dirt from entering the space between these two

parts. It also prevents draft and thus does away with fly, which would otherwise gather and come through in lumps.

22. Doffer Comb.—The cotton is carried around by the doffer on its under side until it reaches the doffer comb *n*, Fig. 3, which is directly in front of the doffer and has an oscillating motion of about 1,800 or 2,000 strokes per minute. One of the bearings of the comb is an ordinary bearing,

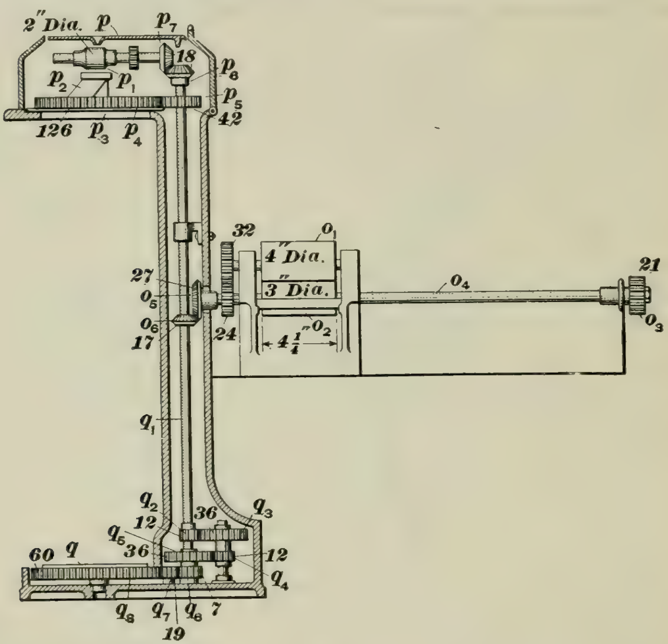


FIG. 19

while the other is in a box known as the **comb box,** which contains the eccentric that gives the motion to the comb. The position of these bearings can be altered by adjusting screws in order to obtain the proper distance between the comb and the surface of the doffer. The comb, as shown in Figs. 1, 2, and 3, consists of a thin sheet of steel attached to a shaft by a number of small arms; its lower edge is composed of fine teeth resembling somewhat the teeth of a fine

saw. The teeth of the doffer, which were pointing upwards when in position to receive the cotton from the cylinder, are pointing downwards at the point nearest the comb. The downward strokes of the comb are in the same direction that the teeth of the doffer are pointing and in close proximity to them, thus making the operation of removing the cotton very easy.

The cotton, when it leaves the doffer, is in the form of a transparent web of the same width as the doffer. The next work required of the card is that of reducing the web to a sliver. This is attained by passing the cotton through a guide and then through a trumpet o, on the other side of which are two calender rolls o_1, o_2, Figs. 1, 3, and 19. The bottom roll is $4\frac{1}{4}$ inches wide and 3 inches in diameter, and by means of a gear drives the top calender roll, which is self-weighted, being 4 inches in diameter. The object of these rolls is to compress the sliver so that it will occupy a comparatively small space.

23. Coiler.—From the calender rolls o_1, o_2 the cotton passes through a hole in the cover p of the upright framework, known as the **coiler head,** the connections of which are shown in Fig. 19. It is drawn through the hole in the cover by two coiler calender rolls, the one shown being marked p_1, which further condense it, and is then delivered into an inclined tube p_2 on a revolving plate p_3. The end of the tube that receives the cotton is in the center of the plate, directly under the calender rolls p_1, while the end of the tube from which the cotton is delivered is at the outer edge of the plate p_3. At the bottom of the coiler head is a plate q on which rests the can that receives the sliver. In consequence of the sliver being delivered down the rotating tube p_2, it will describe a circle and be laid in the can in the form of coils. The circle described by the bottom of the tube p_2 is little more than half the diameter of the can. If the top of the tube p_2 were directly over the center of the plate q on which the can rests and if the can did not turn, causing the laying of the sliver to depend entirely on the rotation of the coiler

tube, the sliver would be placed in a series of ascending coils, which would have as a center the center of the can, while the outside edges of the coils would be placed some distance from the side of the can. The result of this would be that only a very short length of sliver could be laid in the can and the coils would become entangled, causing the sliver to be broken as it was drawn out. In order to overcome this difficulty the top of the tube p_2 is slightly beyond the center of the plate q, while q is revolving in the opposite direction to that of the tube p_2, but very slowly as compared with the speed of this tube, p_2 making about 26 revolutions to 1 of q. As a result of this arrangement each coil of sliver that is placed in the can is in contact with the side of the can and no one coil comes directly above the preceding coil. A top view of the sliver as it appears when placed in the can in this manner is shown in Fig. 20.

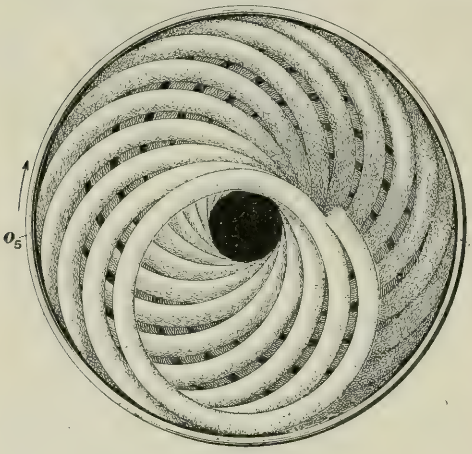


Fig. 20

The cover for the coiler head is now constructed so as to be held in position by a hinge, on which it can be raised and held open, without breaking the sliver. This gives an opportunity for inspection and oiling.

Formerly coiler heads were so constructed that it was necessary to remove the sliver from the coiler or break the end of sliver in order to oil the bearings, which necessarily caused additional waste and loss of production. Occasionally the sliver breaks and collects within the coiler, causing what is called a *bung-up*.

One feature of the coiler head for the card under description is the use of the swinging calender roll in place of the

old-style calender roll, which revolved in fixed bearings and caused considerable trouble in case of a bung-up in the coiler head. The calender roll that receives motion from the upright shaft revolves in fixed bearings, while the other one is mounted on a swing, or hinge, bearing. The weight of the roll and bearing is sufficient to keep it in contact with the fixed roll. It receives motion from the other roll by means of two spur gears, one on the shaft of the roll revolving in fixed bearings and the other on the shaft of the swinging roll. When the coiler tube chokes, the sliver collects around the top of it and forces the swinging roll up, thus throwing it out of gear with the fixed roll and preventing any more cotton from entering the coiler. When a lap forms on either roll, the increasing diameter of the roll forces up the swinging roll and thus prevents the cotton from winding so firmly around the roll. This arrangement is also very convenient because of the fact that the swinging roll can be moved out of the way in removing the cotton that has lapped around one of the rolls, thus making it very easy to remove the lap, whether it has formed on the swinging roll or on the stationary roll. It also does away with the strain on the bearings and the necessity of using a knife to cut the lap from the roll, and thus prevents the surface of the roll from being damaged by the careless use of a knife.

GEARING

24. In describing the method of driving the different parts of the card reference will be made to Figs. 21 and 22, but in order to more fully identify the parts, the plan of the gearing, Fig. 23, and also those figures that show the parts of the card assembled, such as Figs. 1 and 2, should be consulted, especially for those parts that cannot well be indicated on Figs. 21 and 22. Referring first to Fig. 21, which shows the main driving side of the card, the tight pulley e_{12} on the end of the cylinder shaft receives motion from the driving belt e_{14}, which is driven from the pulley either on the main shaft or a countershaft of the room. On the other side of the cylinder, as shown in Fig. 22, is placed a pulley with four

separate faces, the face e_{15} carrying the crossed belt that drives the pulley c_5 on the licker c. Referring again to Fig. 21, on the other end of the licker is a pulley c_6 that drives the barrow pulley m_7 by means of a crossed belt. Compounded

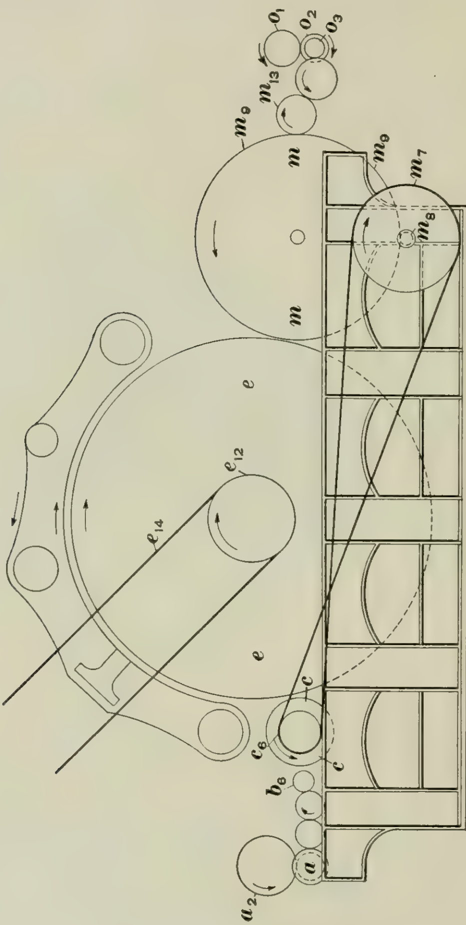


Fig. 21

with this pulley is the barrow gear m_8, which drives the doffer gear m_9 on the end of the doffer shaft.

Reference should now be made to Fig. 22, which shows the other side of the doffer. On this side is a bevel gear m_{10}

driving a bevel gear m_{11} on the side shaft m_{12}, which carries at its other end a bevel gear b_4 driving a gear b_5 on the end of the feed-roll. On the other end of the feed-roll, as shown in Fig. 21, is a gear b_6 that drives by means of two carrier gears the lap roll a. Referring again to Fig. 22, the pulley e_{16}, by means of the band n_5, drives the pulley n_4 that is compounded with another pulley n_2; this, by means of the band n_3, drives a pulley n_1 on a short shaft carrying the eccentric that gives motion to the doffer comb. A third pulley e_{17} on the end of the cylinder shaft, as shown in Fig. 22, drives by

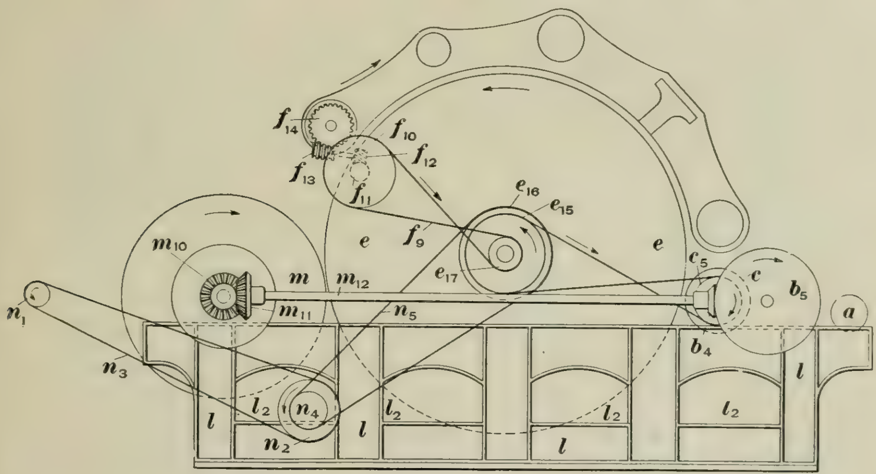
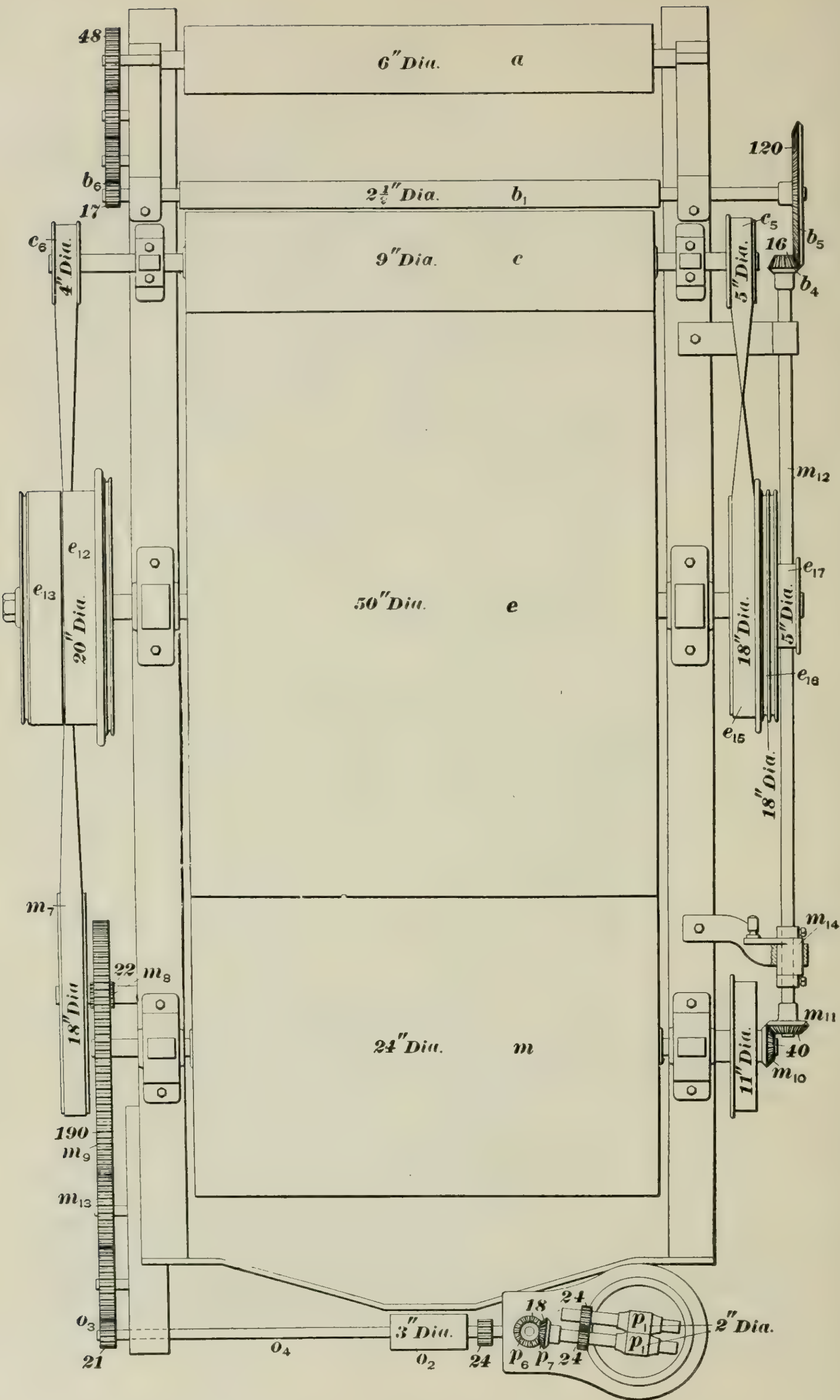


Fig. 22

means of the belt f_9 the pulley f_{10}, which is on the same shaft as the worm f_{11} gearing into the worm-gear f_{12}. On the short shaft with the worm-gear f_{12} is a worm f_{13} driving the worm-gear f_{14}, which is mounted on a shaft carrying two sprockets that gear directly into the ribs on the back of the flats.

The coiler connections are driven as follows, reference being made to Figs. 19 and 23: The large gear m_9, Fig. 23, that is on the end of the doffer and receives motion from the barrow gear, drives by means of two carrier gears a gear o_3 on one end of the calender-roll shaft o_4. On the other end of this shaft is a bevel gear o_5, Fig. 19, that drives



48
6" Dia.
a
120
b6
17
2½" Dia.
b1
c6
4" Dia.
c5
9" Dia.
c
5" Dia.
16
b5
b4
m12
e12
e13
20" Dia.
50" Dia.
e
18" Dia.
e17
5" Dia.
e16
e15
18" Dia.
m7
m14
22
m8
18" Dia.
24" Dia.
m
m11
11" Dia.
40
m10
190
m9
m13
18
24
o3
3" Dia.
p1
2" Dia.
21
o4
o2
24
p6
p7
24

Fig. 23

the bevel gear o_6 on an upright shaft. At the upper end of this upright shaft are two gears, the gear p_5 driving the gear p_4 on the coiler plate, while the bevel gear p_6 drives the bevel gear p_7 on the coiler calender-roll shaft. The can table q is driven by means of a number of gears at the bottom of the upright shaft and in a rather circuitous manner, which is rendered necessary in order to obtain the slow motion at which the can table should travel. The gear q_2 is fast to the upright shaft q_1, while the gears q_5, q_6 are loose on the same shaft but compounded by means of a sleeve. The gear q_2 drives the gear q_3, which is compounded with the gear q_4, both gears working loosely on a short upright stud. The gear q_4 drives the gear q_5, and since q_5 and q_6 are compounded, the gear q_8 on the can table will receive motion through the carrier q_7.

25. When it is desired to stop the card from delivering the cotton and yet not break down the end at the coiler, the catch l_4, Fig. 24, is released. This figure shows one method of driving a doffer; it will be seen that as the feed-roll, calender roll, and all coiler connections are driven from the doffer, they will stop when the catch l_4 is released, throwing the gear m_8 out of contact with the doffer gear m_9. By this method it is a simple matter to stop the delivery of the cotton very suddenly if necessary and at the same time allow the swiftly revolving parts, such as the cylinder and licker, to remain in motion. Another advantage of this arrangement is that no waste results when the delivery is stopped. When the gear m_8 is again meshed with the gear m_9, the portion of the doffer that was presented to the cylinder when the doffer was stopped will contain an excessive amount of cotton. This excess will cause a thick or uneven place in the sliver, which should be removed. This arrangement is sometimes called the *barrow motion*, and the gear m_8 the *barrow gear*.

The gear m_8 is usually a change gear, so that the doffer may be driven at any required speed, as the production of the card depends on the speed of the doffer. In decreasing or increasing the speed of the doffer by changing the

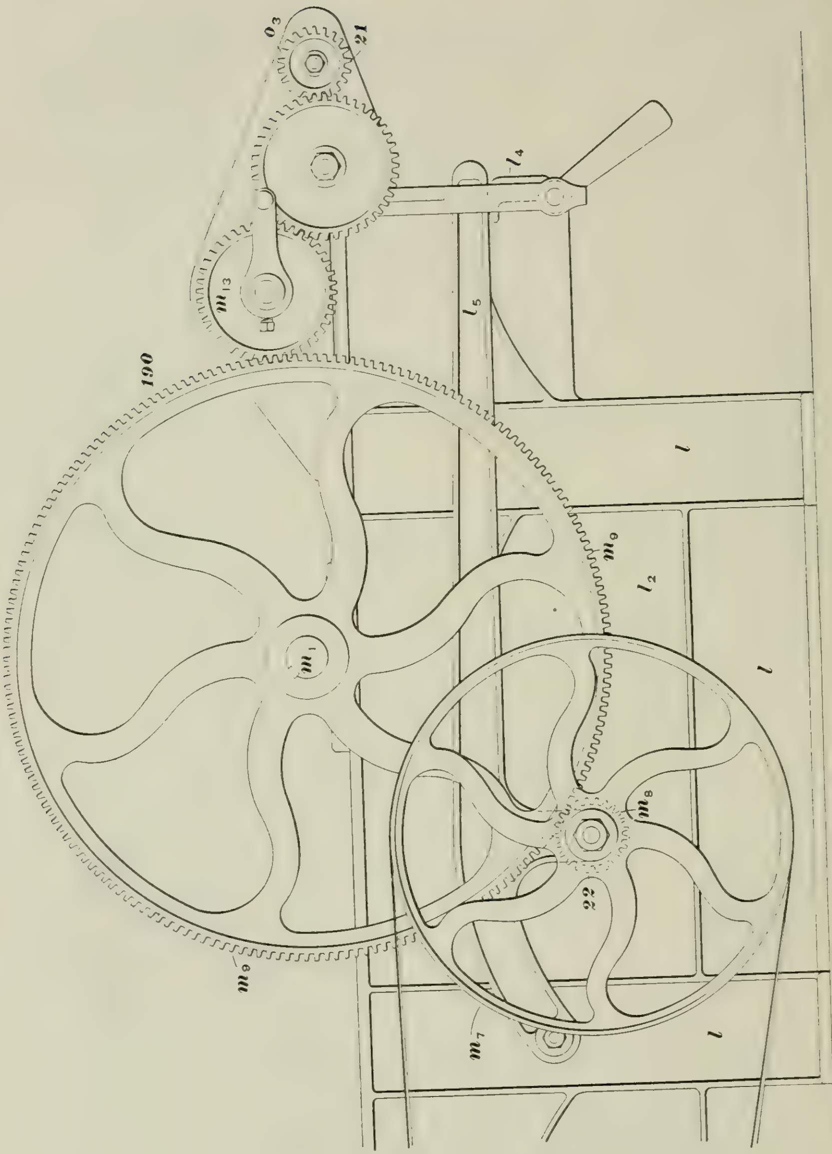


FIG. 21

gear m_8, the draft of the card and, consequently, the weight of the sliver delivered, are not affected, since the feed-rolls, lap roll, and all coiler connections receive motion from the doffer and therefore have the same relative speed, whether m_8 is a large or a small gear.

Another method of stopping the delivery of the cotton without breaking down the end at the coiler is to break the connection at the doffer by moving the side shaft m_{12}, Figs. 22 and 23, and also break the connection between the doffer and calender rolls by turning the handle on the carrier gear m_{13}, Fig. 24. The shaft m_{12} carries a gear at each end, the gear b_4 driving the gear b_5 that is on the end of the feed-roll, while the gear m_{11} receives motion from the gear m_{10} on the end of the doffer shaft. By means of the movable bearing m_{14}, it is possible to move the shaft m_{12} outwards at its front end and thereby disconnect the gears m_{10}, m_{11} and thus stop the feed, while by throwing out the gear m_{13} the calender rolls are stopped, thus allowing the cotton that is on the doffer to fall between the doffer and the calender rolls. This method of stopping the delivery of cotton by the card allows the doffer to run without making an uneven and cut sliver when restarting.

SPEED CALCULATIONS

26. If the driving shaft makes 340 revolutions per minute and carries a 10-inch pulley, the pulley e_{12}, Figs. 21 and 23, which is 20 inches in diameter, will be driven as follows:

$$\frac{340 \times 10}{20} = 170 \text{ revolutions per minute}$$

As the cylinder is $50\frac{3}{4}$ inches in diameter, allowing $\frac{3}{4}$ inch for clothing, its surface speed will therefore be as follows:

$$\frac{170 \times 50\frac{3}{4} \times 3.1416}{12} = 2{,}258.679 \text{ feet per minute}$$

27. Licker.—On the end of the cylinder opposite that of the pulley e_{12} is the pulley e_{15}, Figs. 22 and 23, which is connected to the pulley c_5 by means of a cross-belt and thus

drives the licker. The diameter of e_{15} is 18 inches and that of c_5 is 7 inches, so that when the cylinder makes 170 revolutions per minute, the revolutions per minute made by the licker will be as follows:

$$\frac{170 \times 18}{7} = 437.142 \text{ revolutions per minute}$$

As the licker is usually 9 inches in diameter, its surface speed will be as follows:

$$\frac{437.142 \times 9 \times 3.1416}{12} = 1{,}029.993 \text{ feet per minute}$$

28. Doffer.—The 4-inch pulley c_6, Figs. 21 and 23, on the end of the licker drives the 18-inch barrow pulley m_7, which is compounded with the doffer change gear m_8. This gear, for the purpose of calculation, will be assumed to have 22 teeth; the gear on the end of the doffer contains 190 teeth. With the licker making 437.142 revolutions per minute, the speed of the doffer will be as follows:

$$\frac{437.142 \times 4 \times 22}{18 \times 190} = 11.248 \text{ revolutions per minute}$$

As the doffer is $24\frac{3}{4}$ inches in diameter, allowing $\frac{3}{4}$ inch for clothing, its surface speed will be as follows:

$$\frac{11.248 \times 24\frac{3}{4} \times 3.1416}{12} = 72.881 \text{ feet per minute}$$

On some cards there is an arrangement for driving the doffer at two different speeds, the slow speed being used when piecing up an end. One method of construction for driving at different speeds is to have two pulleys of different sizes on the licker shaft and to have two belts extending to m_7. At m_7 there are three pulleys, the center pulley being loose, while the other two are fastened to the shaft; consequently, when one belt is on the loose pulley, the other is on one of the fastened pulleys. The belts are shifted by means of a shipper handle.

29. Flats.—With the cylinder making 170 revolutions per minute; diameter of e_{17}, Figs. 22 and 23, 5 inches; diameter of f_{10}, 10 inches; f_{11}, single-threaded worm; f_{12},

16 teeth; f_{13}, single-threaded worm; f_{14}, 42 teeth; and diameter of pulley driving flats, 8 inches; the speed of the flats will be as follows:

$$\frac{170 \times 5 \times 1 \times 1 \times 8 \times 3.1416}{10 \times 16 \times 42} = 3.179 \text{ inches per minute}$$

30. Draft.—The following examples illustrate the manner of finding the draft:

EXAMPLE 1.—Find the draft between the lap roll and feed-roll, referring to Fig. 23 for data.

SOLUTION.— $\frac{2.5 \times 48}{6 \times 17} = 1.176$, draft. Ans.

EXAMPLE 2.—Find the draft between the feed-roll and doffer, using a 16 change gear at b_4.

SOLUTION.— $\frac{24 \times 40 \times 120}{2.5 \times 40 \times 16} = 72$, draft. Ans.

EXAMPLE 3.—Find the draft between the doffer and bottom calender roll.

SOLUTION.— $\frac{3 \times 190}{24 \times 21} = 1.13$, draft. Ans.

EXAMPLE 4.—Find the draft between the bottom calender roll and coiler calender rolls, referring to Fig. 19 for data.

SOLUTION.— $\frac{2 \times 24 \times 18 \times 27}{3 \times 24 \times 18 \times 17} = 1.059$, draft. Ans.

EXAMPLE 5.—Find the total draft of the card shown in Fig. 23, figuring from the coiler calender rolls p_1, Figs. 19 and 23, to the lap roll a, Figs. 21 and 23, and using a 16 change gear at b_4.

SOLUTION.— $\frac{2 \times 24 \times 18 \times 27 \times 190 \times 40 \times 120 \times 48}{6 \times 24 \times 18 \times 17 \times 21 \times 40 \times 16 \times 17} = 101.433$, draft. Ans.

PROOF.—To prove that intermediate drafts equal total draft, $1.176 \times 72 \times 1.130 \times 1.059 = 101.325$.

31. Waste.—In the passage of the cotton through the card there are several places where waste is made. There is a certain amount under the licker and the cylinder, and also between the wires of the clothing on the flats, cylinder, and doffer. This amount of waste should not as a rule exceed 5 per cent., and the work of the card should be closely watched, especially with regard to the waste under the

cylinder, which should be examined at frequent intervals to see if it contains too much good cotton.

32. Production.—The production of the card varies according to the class of work, a good production on low numbers being from 700 to 1,000 pounds per week, while for fine yarns it is much lower. The weights of delivered sliver suitable for certain classes of work are as follows:

Variety of Cotton	Numbers	Weight per Yard Grains
Average American	1s to 10s	70
	10s to 15s	65
	15s to 20s	60
	20s to 30s	55
	30s to 40s	50
Allan-seed and Peelers	40s to 60s	50
	60s to 70s	45
	70s to 100s	40
Egyptian	40s to 60s	55
	60s to 70s	50
	70s to 100s	45
Sea-Island	70s to 100s	35
	100s upwards	30

33. Weight and Horsepower.—The weight of a single revolving flat card is about 5,000 pounds. It requires from $\frac{3}{4}$ to 1 horsepower to drive it after the initial strain of starting, which requires much greater power.

34. Dimensions.—A 40-inch revolving flat card with a 24-inch doffer occupies a space about 9 feet $11\frac{1}{2}$ inches by 5 feet 4 inches. Extra allowance must be made for the diameter of the lap. When the doffer is 45 inches wide, 5 inches must be added to the width in the above dimensions, while 3 inches must be added to the length when the doffer is 27 inches in diameter.

COTTON CARDS

(PART 2)

FORMER METHODS OF CARD CONSTRUCTION

1. While the machine described in *Cotton Cards*, Part 1, is the one that is now almost universally adopted for cotton carding, it does not by any means adequately represent the different methods of carding that are, or have been, used. The method of carding cotton before the era of machinery was by means of hand cards, which consisted merely of pieces of wood about 12 inches long and 5 inches wide to which a handle was attached. A piece of leather through which a number of iron wires had been driven was attached to the surface of the board and two of these hand cards were used, the operator holding one in each hand. The cotton, after being picked and cleaned, was spread on one of these cards, and the other was used to brush, scrape, or comb it until the fibers of cotton lay comparatively parallel to one another. From this were obtained soft fleecy rolls about 12 inches long and $\frac{3}{4}$ inch in diameter, called *cardings*. These cardings were pieced together and spun on the hand spinning wheel. Later developments resulted in the introduction of the principle of carding by means of a cylinder carrying wire teeth operating against a stationary framework carrying wire teeth, this being the first style of mechanical card. From this was ultimately developed a card used very largely in America under the name of *stationary-top flat card*, and to a limited extent in Europe, under the name of the *Wellman card*. This stationary-top flat card was used in almost every

American cotton mill until within the last 10 years, and is still used occasionally.

The most popular style of card in Europe prior to the development of the revolving-top flat card was that known as the *roller-and-clearer card*, sometimes called the *worker-and-stripper card*. This roller-and-clearer card was constructed with either one or two cylinders, being known respectively as a single or a double card. Sometimes a combination card was built with rollers and clearers on the back cylinder and flats on the front; combination cards have also been built with single cylinders having flats at the front and rollers and clearers behind. For special purposes cards have been built with three cylinders. The system of carding cotton by rollers and clearers, or workers and strippers, somewhat resembles the methods now in use for carding purposes in the woolen industry.

Owing to the world-wide tendency now to adopt the revolving-top flat card in the cotton industry, considerable space has been devoted to thoroughly describing that style of construction, but as there are still in use a number of stationary-top flat cards and also a number of the roller-and-clearer cards, a brief description of each of these styles of construction will be given.

STATIONARY-TOP FLAT CARD

2. The **stationary-top flat card,** shown in Fig. 1, is a smaller and less substantial machine than the revolving-top flat card, but is very similar to it in the principle of carding the cotton, differing mainly in the method of stripping the flats. The machine consists of the usual framework supporting the cylinder and doffer together with the various parts common to all cards, while above the cylinder are placed a number of flats. In the older cards these are constructed of wood, as shown in Fig. 1, but in the newer cards they are made of iron. Iron flats are usually made $1\frac{3}{8}$ inches wide with a strip of clothing $\frac{13}{16}$ inch wide, and it is possible to have 40 of them extending over an arc equal to about two-fifths of the circumference of the cylinder. When wooden flats

are used it is not possible to have so many. The functions of these flats are the same as of those in the revolving flat card previously described. The flats rest on the arch of the card and are so constructed as to preserve the proper angle with the card wire on the cylinder. Each flat is set independently of any other by means of threaded pins secured by nuts.

The peculiarity of this card consists in the method of stripping the flats. An arrangement is shown above the

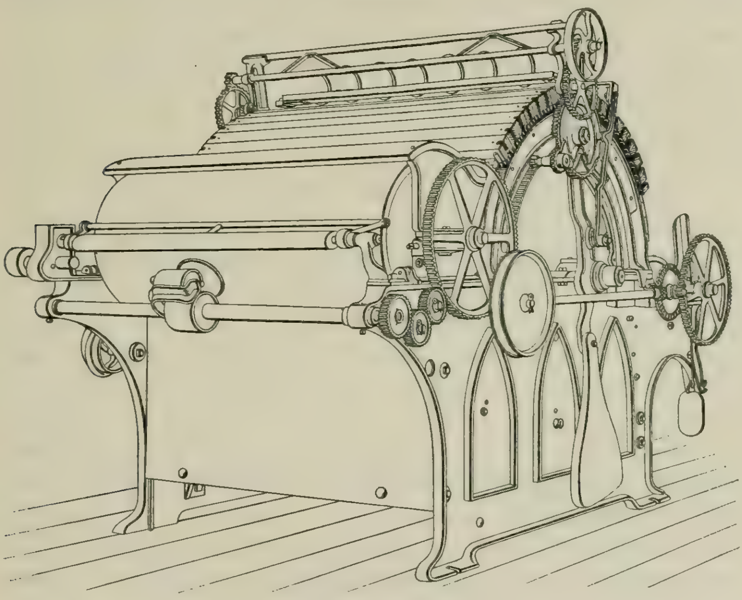


FIG. 1

machine in Fig. 1 by which any one flat may be raised from its seat sufficiently to allow a stripping card to be passed beneath it and drawn across its face, removing the impurities, which are retained in a wire framework; immediately after the stripping is completed the mechanism lowers the flat to its position. As this one piece of stripping mechanism has to clean each flat, it is necessary to have it so constructed that it may be moved from one flat to another; this is

provided for, as shown in Fig. 1, by means of a small gear, which is a part of the stripping mechanism, meshing with a semicircular rack arranged on the arch of one side of the card; as this gear revolves the mechanism is moved from flat to flat. This can be arranged either to strip the flats consecutively, thus the first, second, third, fourth, and so on, or to strip them alternately, thus stripping the first, third, fifth, seventh and returning to strip the second, fourth, sixth, eighth, etc.; or in the improved quick stripper it may be made variable in its action, in order to strip the flats nearest to the feed-rolls oftener than those nearest to the doffer. This stripper lifts, strips, and replaces a flat in less than 4 seconds. The stationary-top flat cards are usually made with all parts smaller than either the revolving-top flat cards or the roller-and-clearer cards. The main cylinder is not usually more than 42 inches in diameter and the doffer not more than 18 inches, while the width of the card is not generally more than 37 inches. The construction of the stationary-top flat card made it especially suitable to be used in sections of a number of cards that delivered the slivers to a traveling lattice. The latter conveyed them to a *railway head*, a machine that combines all the slivers into one sliver which it deposits into a can in suitable form for the next process. This method was, and is still to some extent, used where double carding is resorted to; however, owing to the comparatively small amount of the production for the floor space occupied and the difficulty of arriving at accurate settings and adjustment, especially where wooden flats are used, it is now largely replaced by the revolving-top flat card.

A modern construction of a stationary-top flat card occupies 9 feet 6 inches by 5 feet 6 inches with a coiler, and 8 feet 2 inches by 5 feet 2 inches without a coiler. When making a 60-grain sliver with the doffer making 10 révolutions it cards about 60 pounds per day; it of course produces more than this on coarse work with a heavier sliver and the doffer running more quickly, and less for fine work with a slower doffer speed and lighter sliver.

ROLLER-AND-CLEARER CARD

3. The **roller-and-clearer card,** a section of which is shown in Fig. 2, although rarely used in America, is employed to some extent in certain parts of Europe. The machine consists primarily of a cylinder d, 45 inches in diameter, which is covered with fillet card clothing and rotates at a surface velocity of about 1,600 feet per minute. Placed over this cylinder are a number of **rollers** e about 6 inches in diameter, sometimes known as **workers,** and also a number of **clearers** f about $3\frac{1}{2}$ inches in diameter, sometimes called **strippers.** Both the workers and clearers are covered with fillet card clothing, the former rotating at a surface velocity of about 20 feet per minute and the latter at a circumferential speed of about 400 feet per minute. The clearers are set in close proximity to the cylinder, and the workers are adjusted both to the cylinder and to the clearers. These settings are obtained by means of screws and setting nuts with which the poppet heads g that support the shafts of the workers and clearers can be adjusted. The clearers are driven from a pulley d_1 on the cylinder shaft by means of a belt, or band, d_2 passing over pulleys on the clearer shafts and also around a binder pulley h. The workers are usually driven by a pulley on the doffer shaft that drives a belt, band, or in some cases a chain passing around pulleys or sprockets on the shafts of all the workers. The card is equipped with an 8-inch licker c, which is covered with fillet and rotates at a surface velocity of about 700 feet per minute; a doffer j of the ordinary construction is also employed.

In operation, a lap a_1 is placed in stands at the back of the card and, resting on a rotating wooden roll a, is fed to the card by means of a fluted feed-roll b_1 and a feed-plate b. As the licker c rotates downwards past the feed-plate, its teeth take the cotton that is fed to it and carry it to the cylinder d. The points of the teeth on the cylinder moving rapidly past the backs of the teeth on the licker results in the former taking the cotton from the latter and conveying it to the doffer. In its passage from the licker to the doffer,

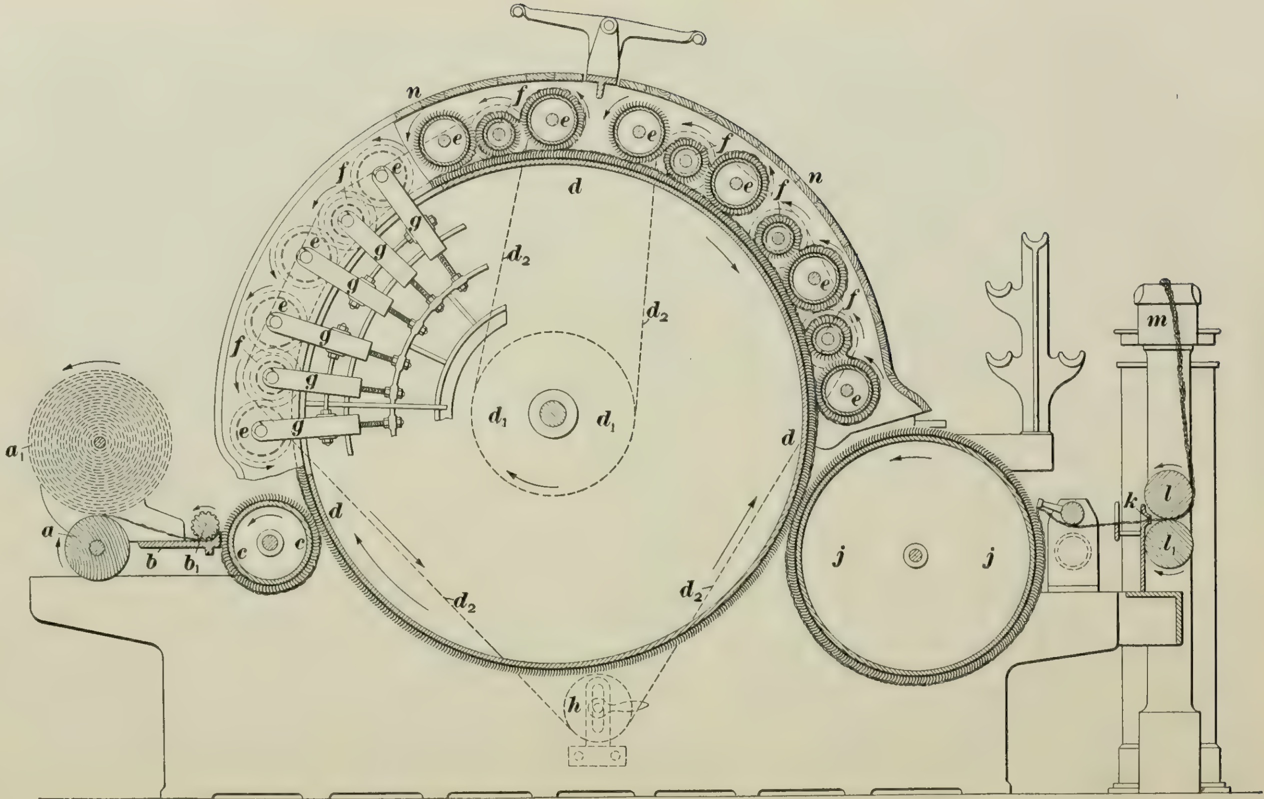


Fig. 2

however, the cotton is subjected to the action of each of the workers. The stock is held loosely and projects somewhat from the teeth of the cylinder, which rapidly pass the workers and operate point against point with the teeth of the latter. The result of this is that the cotton is carded and opened out and deposited on the workers, where it remains until the rotation of the worker brings it under the action of the clearer. Since the teeth of the clearer work with their points against the backs of the teeth on the worker, they take the cotton from the latter and convey it back to the main cylinder, which by virtue of its speed and the direction of inclination of its teeth, strips the cotton from the clearer. The expressions point against point and point against back, when referring to the card teeth of the various rolls, should not be construed to mean that the teeth of any two rolls are in actual contact, as these expressions refer only to the relative inclination of the card teeth. It will be noticed that the first eight workers are arranged in pairs, each pair being stripped by a single clearer, but that the last two workers are each stripped by a separate clearer. Sometimes the entire complement of workers and clearers are arranged as are the last two in the illustration. The cotton is taken from the cylinder by the doffer j in the ordinary manner and passed to the coiler m through the trumpet k and calender rolls l, l_1. This form of card is apt to make a considerable amount of flyings on account of the speed of the various parts, and in order to prevent these from flying from the card the latter is enclosed with a wooden cover n.

This method of carding results in the stock being thoroughly opened and cleaned, and it is claimed that it does less damage to the fibers and that a yarn 5 per cent. stronger can be produced than by the methods in more common use at the present time. As this card, however, requires more help to operate it and does not produce as much work as the more recent card, its use is not considered profitable.

DOUBLE CARDING

4. Formerly in order to obtain a high-grade yarn it was considered necessary to adopt the principle of **double carding;** viz., that of carding cotton first on a breaker card and then, after having taken a number of the slivers and by means of a lap head formed them into a lap, putting this lap through a finisher card. Since the revolving flat card has been improved so greatly that it does almost as good work as was done with the old system of double carding, and since the introduction of the comber, which produces work superior to either double carding or revolving flat card products, double carding is going out of practice.

5. Formation of the Lap.—The cards employed in double carding are similar to those already described and need no further mention. The formation of the lap for the second process of carding may be accomplished in several ways: (1) Where the breaker cards deposit slivers in cans, the lap is usually formed by means of a Derby doubler. (2) Where the first carding is arranged in sections of six, eight, ten, or twelve cards connected by a railway trough, the slivers may be passed through a railway head, in which they are deposited in a can, and afterwards passed through a lap head. (3) The slivers from the section of a railway trough may be guided directly into a lap head and the lap formed in this manner.

The first method, that of using a Derby doubler, is an arrangement by which a number of cans from the breaker cards, varying from twenty to sixty, are placed behind a long **V**-shaped table and the slivers from them passed through rolls, forming at the front one wide sheet, which may be any width from 10 to 40 inches. The lap is wound on a roll in somewhat the same manner as a lap is formed in the picker room. This lap is then placed on the lap roll at the finisher card and recarded.

When it is desired to form a lap for the finisher cards without the intervention of the railway head or can system

for each card, the slivers from the railway trough are guided around rolls at such an angle as to arrange for slivers from two or more lines of breaker cards to be guided into a lap head and there wound into a lap usually half the width necessary to supply the finisher card.

CARD CLOTHING

CONSTRUCTION

FOUNDATION

6. Card clothing is the material with which the cylinder, doffer, and flats of the card are covered and by means of which the cotton is opened and the fibers straightened and laid parallel to each other. It consists of wire teeth bent in the form of a staple and inserted in a suitable foundation material. The teeth in addition to being bent in the form of a staple, also have a forward bend, or inclination, from a point known as the **knee** of the tooth. Fig. 3 is an enlarged view showing the shape of a single card tooth and the method of inserting it in the foundation y. The knee of the tooth is shown at y_1, while y_2 indicates the portion of the tooth, known as the **crown,** that is on the back of the foundation after the tooth has been inserted in it; y_3 are the **points** of the tooth, each tooth of course having two points.

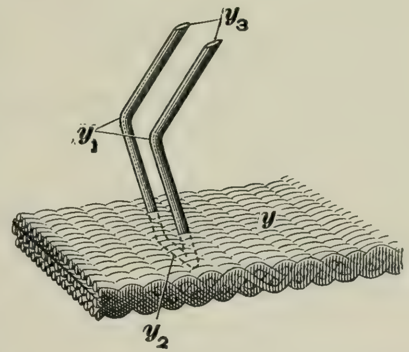


FIG. 3

7. Although the teeth of the clothing do the actual carding, much depends on the character of the foundation, since if the former are not held with considerable firmness and yet allowed a certain freedom of motion, the best results in carding

cannot be obtained. The foundation material must also be such that it will not stretch after it is applied to the card, for if the clothing becomes loose it will rise in places, or as is commonly said, will *blister*. When this happens not only is the thoroughness of the carding deteriorated, but there is also great liability of the clothing itself being damaged by coming in contact with the clothing on other parts of the card. In addition, if the clothing is slack, the teeth will not be held up to their work properly but will be forced backwards by the strain in carding the cotton; this will result in neutralizing to a certain extent the effect of the forward bend of the tooth, making the clothing act more like a brush and allowing the cotton to pass without being properly carded.

The foundation material generally used is a fabric woven from cotton and woolen yarns, although sometimes cotton and linen are employed, the linen being used on account of its strength and freedom from stretching. The woolen yarn, however, is well adapted for this purpose, as it possesses a certain elasticity that, while holding the tooth in place with sufficient security, allows a certain freedom of movement; this is very desirable, since if the card teeth are held too rigidly, there is some liability of their becoming bent or broken. The foundation is generally woven three- or four-ply, in order to obtain the required strength and the thickness that is necessary to secure the teeth. A very good foundation consists of a two-ply woolen fabric inserted between two cotton fabrics, the latter imparting the requisite strength and the former giving a firm but elastic grip on the teeth. Sometimes the surface of the foundation is coated with a veneer of india-rubber, but in this there are disadvantages as well as advantages. The rubber has a yielding grip on the tooth that allows it enough freedom to move when the strain of carding is on it, and at the same time it is of a tough nature so that the movement of the tooth does not work a large hole in the foundation, which would render the teeth loosely secured so that the full benefit of the elasticity of the wire could not be obtained. The india-rubber-covered clothing is also much easier to strip, but on

the other hand is not so durable as clothing made with the ordinary foundation. The rubber deteriorates with age, becoming hard and stiff and cracking between the points where the teeth pass through it. This deterioration is much more rapid if the clothing is in a hot room or subjected to the direct rays of the sun, and many times it has been found that the foundation of rubber clothing was totally spoiled before the wire was appreciably worn.

TEETH

8. The wire teeth actually do the carding, separating the cotton, fiber from fiber, and rearranging it in a homogeneous mass in which the fibers lie more or less parallel; they are therefore of even more importance than the foundation in which they are inserted. The material from which the wire is made, the number (diameter) of the wire, the angle at which the wire passes through the foundation, the angle at the knee of the tooth, the relative height of the knee and point, and the method of insertion in the foundation are all important considerations when card clothing is to be purchased for general or special uses.

Clothing is set with many different kinds of wire, such as iron, brass, mild steel, tempered steel, tinned steel, etc., but for cotton carding hardened and tempered steel, which makes a springy, elastic tooth that will not easily be bent out of place or broken, is the best material. Mild-steel wire wears too easily, losing its point and requiring frequent grinding to keep the card in good working condition. On the other hand it is easily ground, while tempered steel, although necessitating less frequent grinding, is harder to grind and requires a longer time to secure the required point, since if the grinding operation is forced the wire is liable to become heated and the temper drawn. The strength, elasticity, and durability of the tempered steel, however, make it much more desirable than any other material.

The wire generally employed is round in section, but various other shapes have been used at different times; one

of these was the elliptical form obtained by slightly flattening the round wire by passing it through heavy rolls. While this form gave great strength to the tooth, it was objectionable because the teeth had a tendency to work holes in the foundation. After round wire has been set in the foundation it is ground to a point, and this alters the form of the section of the tooth at the point, or in some cases as far down as the knee, although the part of the tooth that passes through the foundation is always round in section. There are three methods of grinding the clothing, which give to it the following names: (1) *top-ground;* (2) *needle-*, or *side-*, *ground;* (3) *plow-ground.*

9. Top-ground wire is obtained by an emery grinding roll having a very slight traverse motion, so that the point of the tooth is ground down only on the top, producing what is known as a **flat**, or **chisel**, point.

In the **needle-**, or **side-**, **ground wire** the thickness of the tooth is reduced at the sides for a short distance from the point, and the wire is also ground down at the top. This form of point is known as the **needle point** and is produced by a comparatively narrow emery grinding wheel that, in addition to having a rotary motion, is rapidly traversed back and forth across the clothing.

Both top and needle grinding are practiced in the mill, the former being accomplished with the so-called dead-roll and the latter with the traverse grinding roll, but **plow grinding** is usually done by the manufacturers of the clothing. With this method of grinding, the thickness of the wire is reduced by grinding down each side from the point of the tooth to the knee. This is accomplished by means of emery disks that project into the clothing to the knee of the tooth. To aid in this method of grinding, the teeth are separated by means of plows, or guides, so that the emery disk will pass between the wires and not knock down the teeth, hence the name plow-ground. A plow-ground tooth is the best, since it is not only strong, elastic, and easily kept in good condition, but also gives a wedge-shaped space

between the teeth, which can more readily engage with the cotton, and at the same time does not reduce the number of points per square foot. It should be understood that plow grinding alone does not give the necessary keen point to the tooth, as it simply reduces the section of the tooth from the knee up by grinding the sides flat; consequently, after the wire has been plow-ground it must be either top-ground or needle-ground, in order to bevel the tooth and bring it to a point.

10. Diameter of Wire.—The diameter of the wire varies according to the class of cotton to be carded, since fine cotton requires clothing with a large number of points per square foot, while coarse work requires fewer points; and in the former case fine wire must be used, while in the latter case wire of a large diameter is more suitable. As will be explained later, it is customary to set the clothing with a certain number of points per square foot for a certain diameter of wire. There are two gauges employed for numbering wire; namely, the Birmingham, or Stubbs, which is the English standard, and the Brown & Sharpe, which is the American standard. The following table shows the comparative diameters, expressed in decimal parts of an inch, of different numbers of wire of each system:

TABLE I

Birmingham Diameter in Inches	Number of Wire	American Diameter in Inches
.014	28	.012641
.013	29	.011257
.012	30	.010025
.010	31	.008928
.009	32	.007950
.008	33	.007080
.007	34	.006305
.005	35	.005615
.004	36	.005000

For an average grade of cotton, No. 33 wire (American gauge) for the doffer and flats and No. 32 for the cylinder will give good results; for coarse work the wire is proportionally increased in diameter, and for finer work proportionally decreased. The cylinder should always be covered with wire one number coarser than the doffer and flats, which should have wire of the same diameter.

11. In regard to the shape of the tooth and the angle at which it is inserted in the foundation, several important points should be noted. The knee of the tooth should be located about four-sevenths of the length of the tooth from the crown and three-sevenths from the point. If the knee is placed higher the tooth will be stronger and have a harsher action on the cotton, while if the knee is lower the clothing will be more flexible and have a more brush-like action. The tooth should penetrate the foundation at an angle of about 75°, to offset the bend at the knee, so that the point of the tooth will not be too far forwards. The angle of insertion in the foundation and the bend of the knee should be such that the point of the tooth will just touch or very slightly pass a perpendicular line drawn from the point where the tooth emerges from the foundation.

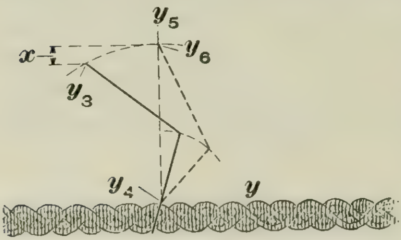


FIG. 4

Should the forward inclination be such that the tooth passes the perpendicular to any great extent, the point of the tooth will rise when it is moved back by the strain of carding. This is more clearly shown by reference to Fig. 4. Suppose that the shape of the tooth is such that its point is inclined forwards past the perpendicular y_4, y_5, as shown at y_3; then when the strain comes on the tooth, the point will be moved back to y_6, owing to the flexibility of the tooth and the freedom of motion allowed by the foundation. The point, therefore, in swinging through the arc $y_3 y_6$ will rise through the distance x, which in the case of

a close setting might be sufficient to make the wire strike the clothing on other parts of the card. This action of the tooth is also aggravated by the tendency to straighten at the knee, so that even if no contact results, the setting will be made much closer and many fibers will be broken. On the other hand, if the inclination of the tooth does not carry its point past the perpendicular, the tendency of the tooth in moving backwards under the strain of carding will be to depress the point, making the setting more open and reducing the strain.

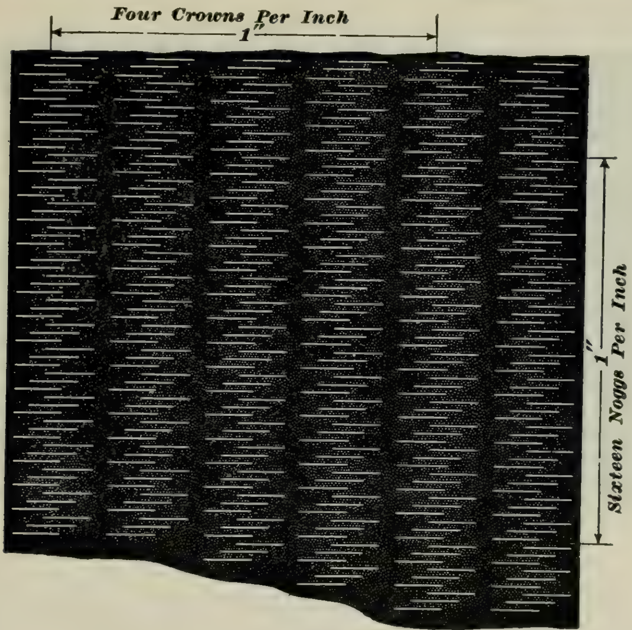


Fig. 5

CALCULATIONS

12. Card clothing for cotton cards is made in long continuous strips 1, $1\frac{1}{4}$, $1\frac{1}{2}$, $1\frac{3}{4}$, and 2 inches in width known as **fillet, or filleting,** and in narrow sheets known as **tops**; the former is used for covering the cylinder and doffer, while the latter is used for the flats. Fillet clothing is made in what is known as **rib set**; that is, with the crowns of the teeth,

which are on the back of the clothing, running in ribs, or rows, lengthwise of the fillet. Fig. 5 shows the appearance of the back of a piece of $1\frac{1}{2}$-inch rib-set fillet, the horizontal lines indicating the crowns of the teeth and showing the method in which they are inserted. The teeth are set into tops so that the crowns of the teeth on the back side of the foundation are **twilled**; that is, they are set in diagonal lines like a piece of twilled cloth. Fig. 6 shows the appearance of the back of a top, the horizontal lines showing the method of twilling the crowns.

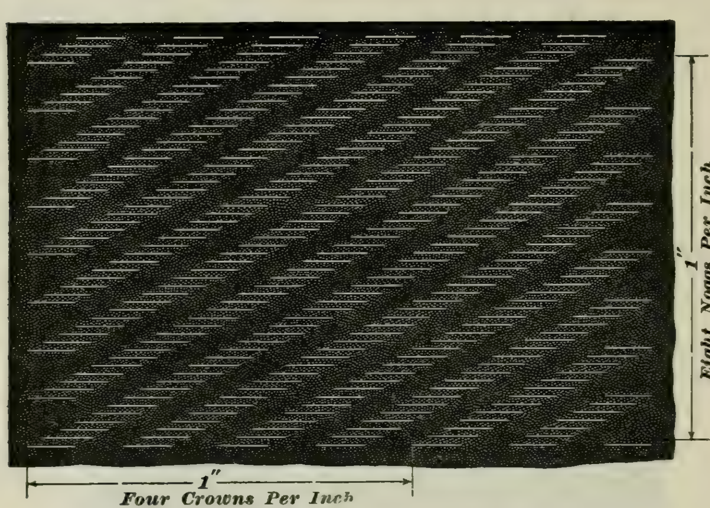


Fig. 6

All card clothing in America, unless especially ordered, is made with 4 crowns in 1 inch on the back of the clothing, or 8 points in 1 inch on the face, and is known as 8-crown clothing. From this it will be seen that a 2-inch fillet will have 8 ribs on the back and a $1\frac{1}{2}$-inch fillet, 6 ribs, etc. It should be noted that the actual width of the foundation of fillet clothing is about $\frac{1}{16}$ inch greater than the width of the wire-covered space; thus, a 2-inch fillet is actually $2\frac{1}{16}$ inches in width. Sometimes in special cases where a large number of points per square foot are desired, the clothing is made

10-crown; that is, with 10 points per inch in width on the face of the clothing, or 5 crowns per inch on the back of the clothing.

The term **nogg,** which is used in connection with card clothing, refers to the distance between the first tooth of one line of twill and the next line. It will be noticed in Fig. 6 that there are 6 teeth to a nogg and 8 noggs per inch, while in Fig. 5 there are half as many teeth per nogg and 16 noggs per inch. Owing to the manner in which the teeth are set in fillet clothing, there are always one-half the number of teeth per nogg and twice the number of noggs per inch as in clothing for tops with the same number of points per square foot. The number of noggs per inch always governs the number of points per square foot in the clothing. If more points per square foot are wanted, the noggs per inch are increased, while if fewer points are wanted, the noggs per inch are decreased, the crowns always remaining the same.

13. To find the points per square foot in card clothing:

Rule.—*Multiply the crowns per inch by the points per tooth* (2), *by the teeth per nogg, by the noggs per inch, and by the number of square inches in a square foot* (*144*).

EXAMPLE 1.—Find the points per square foot in the sample of card clothing shown in Fig. 5, the crowns per inch being 4, the teeth per nogg 3, and the noggs per inch 16.

SOLUTION.—

```
      4 crowns per in.
      2 points per tooth
      -
      8 points per in.
      3 teeth per nogg
     --
     24
     16 noggs per in.
    ---
    144
    24
    ---
    384 points per sq. in.
    144 in. per sq. ft.
   ----
   1536
  1536
  384
  -----
  55296 points per sq. ft.   Ans.
```

Dividing the points per square foot by the noggs per inch, thus, 55,296 ÷ 16 = 3,456, it will be noticed that with 8-crown fillet (4 crowns per inch) each nogg increases the points per square foot by 3,456. From this it will be seen that in order to find the points per square foot in 8-crown fillet clothing, it is only necessary to multiply the noggs per inch by 3,456.

EXAMPLE 2.—Find the points per square foot in the sample of card clothing shown in Fig. 6, the crowns per inch being 4, teeth per nogg 6, noggs per inch 8.

SOLUTION.—

$$
\begin{array}{rl}
4 & \text{crowns per in.} \\
2 & \text{points per tooth} \\
\hline
8 & \text{points per in.} \\
6 & \text{teeth per nogg} \\
\hline
48 & \\
8 & \text{noggs per in.} \\
\hline
384 & \text{points per sq. in.} \\
144 & \\
\hline
1536 & \\
1536 & \\
384 & \\
\hline
55296 & \text{points per sq. ft.} \quad \text{Ans.}
\end{array}
$$

Dividing the points per square foot by the noggs per inch, thus, 55,296 ÷ 8 = 6,912, it will be noticed that with 8-crown twill-set clothing each nogg increases the points per square foot by 6,912. From this it will be seen that in order to find the points per square foot in twill-set clothing it is only necessary to multiply the noggs per inch by 6,912.

In Table II is given the number of points per square foot of 8-crown, rib-set fillet (4 crowns per inch) with 3 teeth per nogg and with from 10 to 27 noggs per inch, and also shows the numbers of wire (American gauge) generally used in each case.

In Table III is given the number of points per square foot of 8-crown, twill-set clothing with 6 teeth per nogg and with from 5 to 13 noggs per inch and also shows the numbers of wire (American gauge) generally used in each case.

For an average grade of cotton the doffer should have 20 or 21 noggs per inch and the flats 10 or 10½ noggs per

TABLE II

Noggs per Inch	Points per Square Foot	American Number of Wire
10	34,560	28
11	38,016	28
12	41,472	29
13	44,928	29
14	48,384	30
15	51,840	30
16	55,296	31
17	58,752	31
18	62,208	32
19	65,664	32
20	69,120	33
21	72,576	33
22	76,032	34
23	79,488	34
24	82,944	35
25	86,400	35
26	89,856	36
27	93,312	36

TABLE III

Noggs per Inch	Points per Square Foot	American Number of Wire
5	34,560	28
6	41,472	29
7	48,384	30
8	55,296	31
9	62,208	32
10	69,120	33
11	76,032	34
12	82,944	35
13	89,856	36

inch, which in each case would give 69,120 or 72,576 points per square foot. For the main cylinder 18 or 19 noggs per inch are suitable, which would give 62,208 or 65,664 points per square foot. The number of points may of course be varied to suit the class of work, but it is generally desirable to have the same number of points in the doffer and flats,

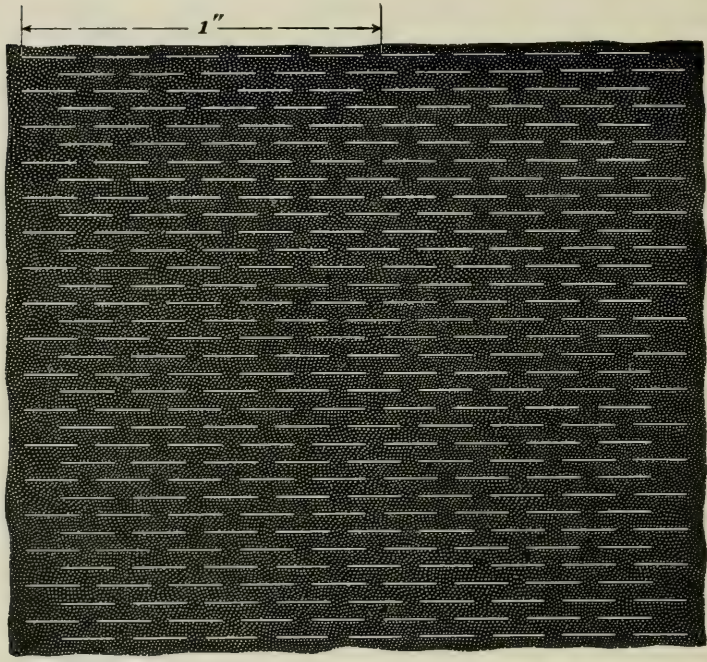


FIG. 7

while the main cylinder should have a slightly smaller number than either.

14. English Method of Numbering Card Clothing. English card clothing was formerly made with the teeth inserted according to a method known as the **plain-,** or **open-, set,** in which the crowns, or backs, of the teeth overlapped each other exactly as bricks in a wall, as shown in Fig. 7. The teeth were inserted in sheets 4 inches in width,

and the clothing was made with 5 crowns on the back, or 10 points on the face, in 1 inch lengthwise of the sheet, or crosswise of the card after the sheet had been applied to the same; that is, it was 10-crown clothing. Plain-set clothing is not often used in America, and although rarely used in England today, it forms the basis of the whole English system of numbering clothing. The English system designates card clothing by the **counts,** a term that indicates the number of points per square foot on the face of the clothing absolutely, but which gives no clue to the method of inserting the teeth, whether plain-, rib-, or twill-set; that is, 100s-count card clothing indicates a definite number of points per square foot and nothing else.

As stated, the English system of numbering card clothing is based on the 10-crown, plain-set clothing, the term counts indicating the number of noggs in 4 inches, which was the original width of the sheets. Thus, if a sheet of plain-set, 10-crown clothing had 60 noggs in its width, it was 60s-count, or if it had 100 noggs in the width of the sheet, it was 100s-count clothing, etc. As plain-set clothing was invariably made on the 10-crown basis, the number of noggs in the width of the sheet, or the counts, always indicated a definite number of points per square foot. For example, in 100s-count clothing, as there are 100 noggs in 4 inches, then in 12 inches, or 1 foot, there are 300 noggs, and as in plain-set clothing there are 2 teeth per nogg, there are $300 \times 2 = 600$ points crosswise of the sheets. Since 10-crown clothing has 10 points per inch, there are $10 \times 12 = 120$ points in 1 foot lengthwise of the sheet, which multiplied by 600 points per foot crosswise of the sheet equals 72,000 points per square foot. From this it will be seen that as 100s-count clothing contains 72,000 points per square foot, each count increases the points per square foot $72,000 \div 100 = 720$ points. Therefore, to find the points per square foot in card clothing of any counts, it is only necessary to multiply the counts by 720; and inversely, to find the counts of any card clothing, divide the points per square foot by 720.

Although plain-set, 10-crown clothing has been largely superseded in both England and America by 8-crown, twilled-set clothing for the flats and 8-crown, rib-set clothing for the cylinder and doffer, the English system of numbering clothing is still based on the plain-set clothing, in which each count is equal to 720 points per square foot. Table IV shows the points per square foot in card clothing of various counts and also the number of wire (American gauge) that is usually used.

TABLE IV

English Counts	Points per Square Foot	American Number of Wire
60s	43,200	28
70s	50,400	30
80s	57,600	31
90s	64,800	32
100s	72,000	33
110s	79,200	34
120s	86,400	35
130s	93,600	36

METHOD OF CLOTHING CARDS

CLOTHING FLATS

15. The clothing for the flats is made in sheets with a 1-inch space between the sections of wire; these are afterwards cut up to form the **tops**. Formerly one of the most difficult problems for cotton-card builders and manufacturers of card clothing was to attach satisfactorily the top to the flat. The first method employed was to drill holes in each edge of the flat and secure the clothing by rivets. This method, while it held the clothing securely, had a tendency to weaken the flats, causing them to deflect; and in addition, the cotton occasionally caught on the rivets until a bunch was formed, which would pass into the card again and form

a nep in the web. Another method was to sew the top to the flat, but this was not entirely satisfactory.

The present method is to employ a steel clamp of the same length as the clothing and bent in a **U**-shape. One edge of this clamp in some cases is serrated, so as to grip the foundation, while the other edge engages the edge of the flat, holding the clothing and flat securely together. The foundation of the card clothing is pulled toward the edges of the flat and clamps applied simultaneously to both edges, so that the clothing is fastened while under tension. Afterwards end pieces are usually fastened on in order to make the clothing absolutely secure. The flats should be ground after the clothing is applied, so as to make them perfectly true.

CLOTHING CYLINDER AND DOFFER

16. Both the cylinder and doffer, which are covered with filleting, have parallel rows of holes drilled across them, which are plugged with hardwood. The fillet is wound spirally and secured by means of tacks driven in the hardwood plugs. Cylinders are usually covered with 2-inch, and doffers with $1\frac{1}{2}$-inch, filleting. Formerly it was customary to give the surface of the cylinder a thin coat of paint or cover it with calico before applying the clothing, but the present practice is to wind the fillet on the bare cylinder. The plugs should be flush with the surface of the cylinder, which should be smooth, free from rust, and perfectly dry before the clothing is applied. Since the fillet is wound spirally, it must be tapered at each end of the cylinder or doffer, so that it will not overlap.

17. There are several methods of shaping the *tail-ends*, as they are called, but the best is that known as the **inside taper,** since it is stronger and neater than any other. Fig. 8 (*a*) shows the method of cutting the fillet for an inside taper. Three lengths x, x_1, x_2, each equal to one-half the circumference of the cylinder or doffer, as the case may be, are first marked out on the end of the fillet; in the case of a 50-inch cylinder these distances x, x_1, x_2 would be

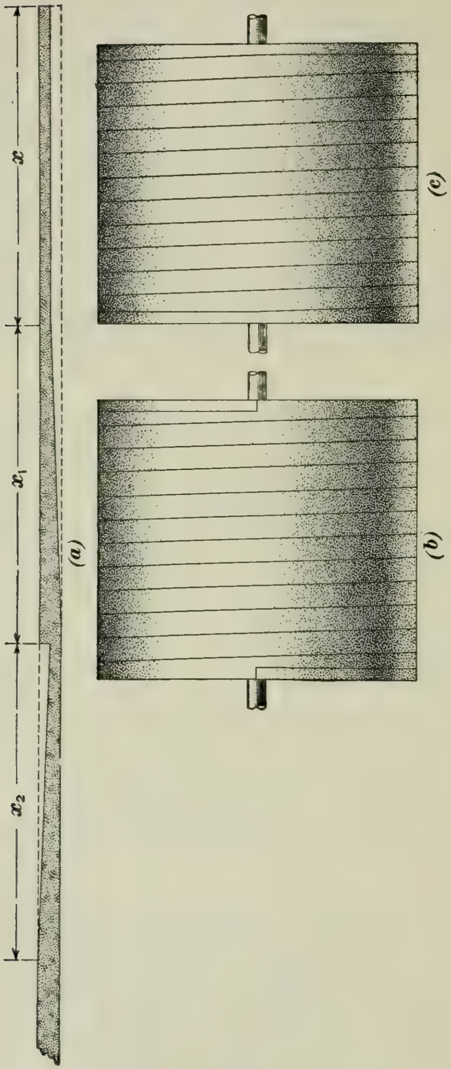


FIG. 8

6.545 feet each. For the first distance x, the fillet is cut exactly through the middle; for the second distance x_1, it is tapered from half the width of the fillet to the full width; for the distance x_2, a cut is made on the opposite side of the fillet exactly half way through it and the fillet tapered out to its full width again. The dotted lines in Fig. 8 (*a*) indicate the original width and shape of the fillet, while the full lines show the shape of the tail-end when cut. Fig. 8 (*b*) shows the method of winding the fillet on the cylinder and the way the tail-ends are fastened. After one tail-end is cut, the end of the fillet is tacked to the plugs in the cylinder and the fillet wound around the cylinder spirally, as shown in Fig. 8 (*b*) and (*c*); the other tail-end is then cut and fastened to the cylinder in the same manner as the first tail-end. Care should be taken in cutting each tail-end to have the straight, or uncut, edge of the fillet x, x_1 coincide with the edge of the cylinder. Fig. 8 (*c*) shows the opposite side of the cylinder shown in Fig. 8 (*b*).

18. To find the length of filleting to cover a cylinder, doffer, or other roll:

Rule.—*Multiply the diameter of the roll by its width* (*both expressed in inches*) *and by 3.1416 and divide the product thus obtained by the width of the fillet multiplied by 12. The result thus obtained will be the required number of feet of filleting.*

Note.—An allowance must be made for tapering the tail-ends, generally a length equal to the circumference of the roll being sufficient.

Example.—What length of 2-inch filleting is required to clothe a cylinder 50 inches in diameter and 40 inches wide?

Solution.— $\frac{50 \times 40 \times 3.1416}{2 \times 12} = 261.8$ ft.

Adding a length equal to the circumference of the cylinder, which is 13.09 ft., the length required will be 274.89 ft. Ans.

19. Fillet-Winding Machine.—Before applying the fillet, it should remain for several days in the room in which it is to be used; otherwise, it will have a tendency to expand after being fixed on the cylinder, which causes it to rise in

places. The fillet is applied to cylinders or doffers by means of special winding machines; formerly it was wound by hand. Fig. 9 shows a good type of fillet-winding machine, which consists primarily of a carriage *a* that slides on a bed *b*. Sufficient motion is imparted to the carriage, by means of a rotating screw *c* that engages with a gear c_1 on a shaft, to guide the spirals of fillet close to each other. The gear c_1 is prevented from turning, after the position of the machine

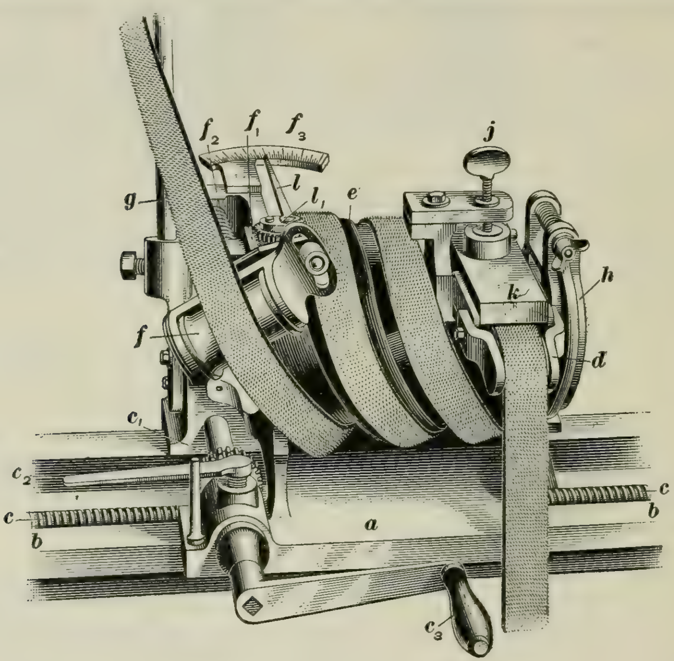


FIG. 9

is once adjusted with the crank c_3, by a lever c_2, which operates a screw that secures its shaft. The fillet when being wound is usually placed in a basket, or other receptacle, from which the end is taken and passed through the trough *d* to what is known as the cone drum *e*, around which it is wrapped three times. The fillet emerges over the roll *f* and is guided on the cylinder to be clothed by the rod *g*. The fillet must always be passed through the trough *d* so that the teeth will

point in the opposite direction to its motion; otherwise, they will be injured.

The tension is obtained in the following manner: The drum *e*, which revolves as the fillet passes over it, is made in three sections—the first $6\frac{1}{2}$ inches, the second 7 inches, and the third $7\frac{1}{2}$ inches in diameter. The section with the largest diameter is covered with leather, so that this portion of the drum and the fillet revolve together; and as it requires a greater length of fillet to cover this surface than it does to cover either of the smaller sections, the fillet is drawn over these at a speed greater than that of their surfaces, which will have the same effect as if the smaller sections were working in a direction opposite to that of the larger section. The friction between the fillet and the drum produces the tension on the former, the amount of which may be regulated by the brake *h* on the drum shaft and also by a thumbscrew *j* that presses the die *k* down on the fillet, which is drawn over a spring cushion in the trough *d*. About 200 pounds tension may be obtained by means of the brake *h* alone, the rest being obtained by means of the thumbscrew *j*. For main cylinders wound with 2-inch fillet, a tension of 270 to 300 pounds is about right; narrower fillet requires less tension. Doffers may have fillet applied with about 175 pounds tension. The amount of tension with which the fillet is being wound in this machine is indicated by a finger *l* on the dial f_3. This is accomplished by arranging the roll *f* to press against a strong coil spring f_2, connection being made with a rack f_1 and pinion l_1, so that the motion of the roll when acted on by the tension of the fillet is communicated to the finger and indicated on the dial.

In using this machine, it is essential that for each revolution of the cylinder being covered the carriage shall move along the bed a distance corresponding to the width of the fillet. This is accomplished by gearing the screw that imparts the traverse motion to the carriage from the cylinder being covered, the train of gears being so arranged that one tooth of the change gear moves the carriage $\frac{1}{32}$ inch to each revolution of the cylinder being covered. From this

it will be seen that $1\frac{1}{2}$-inch fillet will require a 48-tooth gear and 2-inch fillet a 64-tooth gear. In actual practice, however, a 49-tooth gear is used for $1\frac{1}{2}$-inch and a 66-tooth gear for 2-inch fillet, since the fillet is wider than the nominal width and measures $1\frac{17}{32}$ inches and $2\frac{1}{16}$ inches, respectively. A crank arrangement is usually applied to the cylinder and doffer so that they can be turned by hand while the clothing is being applied.

After cylinders are covered with fillet they should be allowed to stand for 3 or 4 hours in order that the fillet may become adjusted, when it should be tacked crosswise of the cylinder.

COTTON CARDS

(PART 3)

CARE OF CARDS

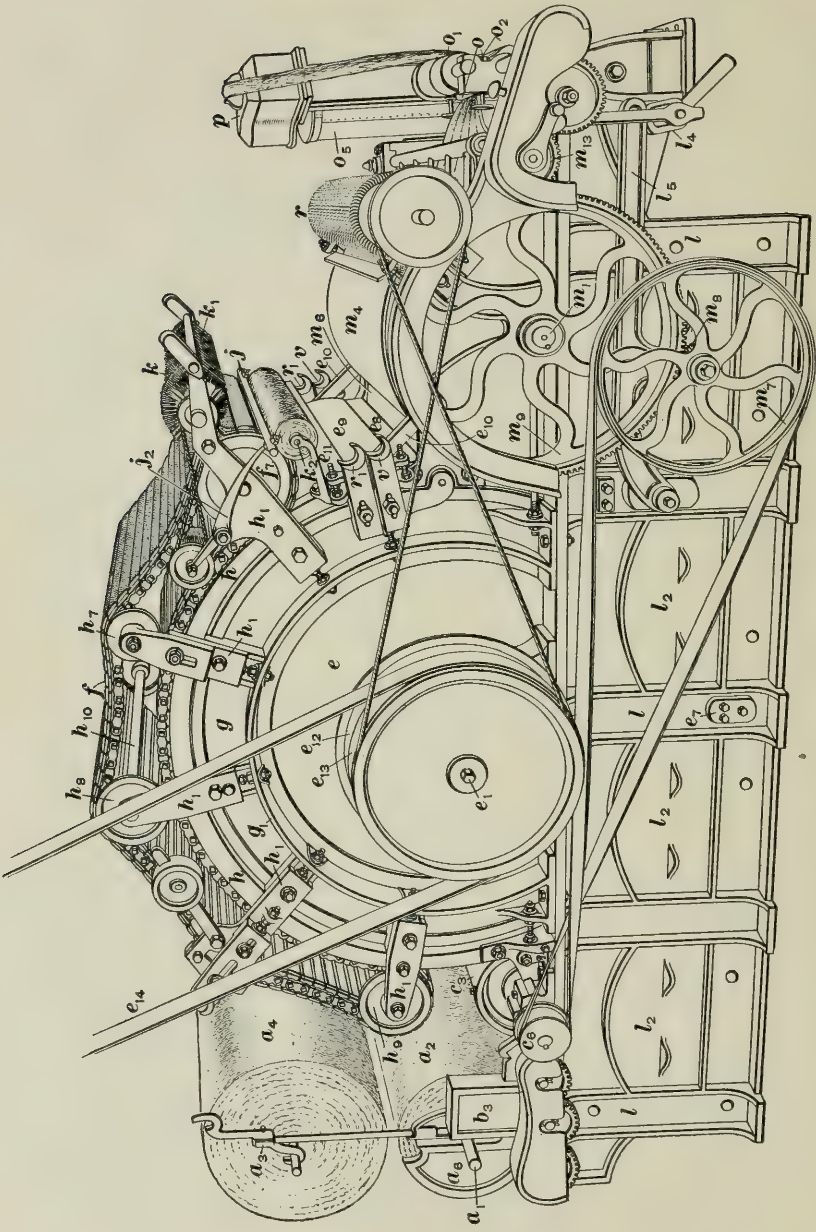
INTRODUCTION

1. The method of managing a card room very materially affects the quality of the product of a cotton mill, as in order to insure satisfactory results it is very essential that the carding process shall have careful attention. Care should especially be given to several important operations that must be performed at intervals.

Those parts of the card that are clothed—the flats, the cylinder, and the doffer—are constantly collecting waste from the cotton that is being operated on. This waste, consisting of short fiber and foreign matter that fills up the interstices of the card wire and prevents the card from doing its best work, must be removed at intervals from the clothing, the process being known as *stripping*. Fig. 1 is a view of a card showing arrangements applied for stripping the doffer and flats.

As the points of the card wire become dull, on account of the constant friction, and consequently do not card the cotton as satisfactorily as when sharp, they must be sharpened by means of emery rolls; this is accomplished by the process known as *grinding*. A view of a card, with arrangements applied for grinding the doffer and cylinder, is shown in Fig. 2.

When two wire surfaces are presented to each other, there



p
o_5
o_1
o
o_2
r
m_{13}
l_5
l_4
l
m_4
m_6
m_1
m_8
m_7
m_9
k
k_1
j
j_2
r_1
v
e_{10}
e_{11}
e_9
e_8
k_2
f_1
h_1
h
h_7
f
h_{10}
h_8
g
g_1
e
e_{12}
e_{13}
e_1
e_7
l_2
e_{14}
a_4
h_9
a_2
c_3
c_6
b_3
a_3
a_6
a_1

FIG. 1

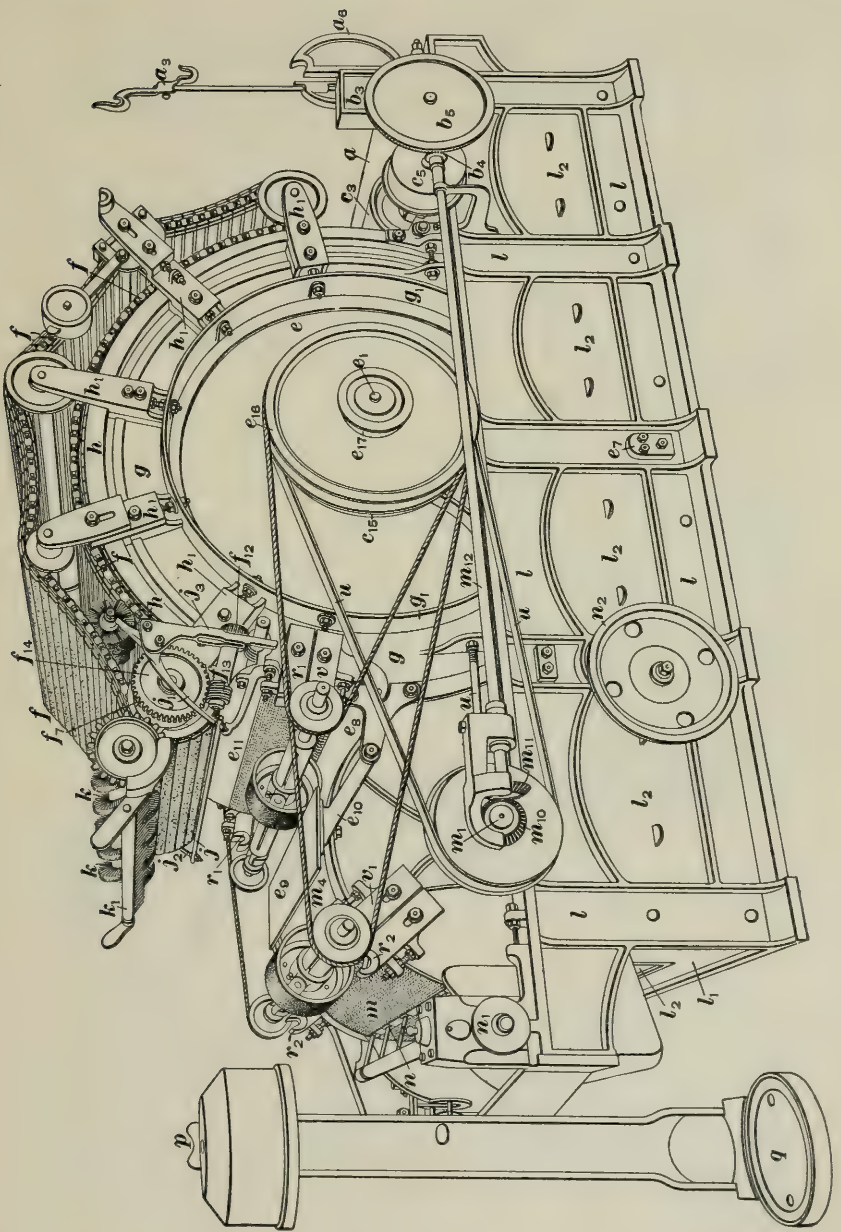

a6
a3
b3
b5
b4
c5
c3
a
h1
f
e
g1
e1
e18
h
g
e17
e7
l2
l
e15
f12
j3
m12
u
n2
f14
j1
f7
r1
v
e8
e11
m11
m10
m1
e10
k
j2
j
k1
e9
m4
v1
r2
m
n1
n
l1
p
q

FIG. 2

is sometimes too much space between them, caused by parts of the card moving slightly out of position or by the shortening of the wire by the grinding process. The operation of regulating the distance between the two wire surfaces is known as *setting*.

In common with all machinery, the oiling of the parts must be periodically attended to, as well as the cleaning of the machine and the removal of fly from below the card. Very little more attention is necessary in connection with carding cotton with the revolving-top flat card other than keeping the machine supplied with laps and removing the cans when full.

STRIPPING

2. Methods of Stripping.—Various methods of **stripping** cards have been adopted. One of the earliest methods used in cotton carding, and one that is now in use in connection with woolen carding, was by means of a flat board from 4 to 6 inches wide and as long as half the width of the card, on the upper part of which a handle was attached, while a piece of card clothing was nailed on the lower part with the

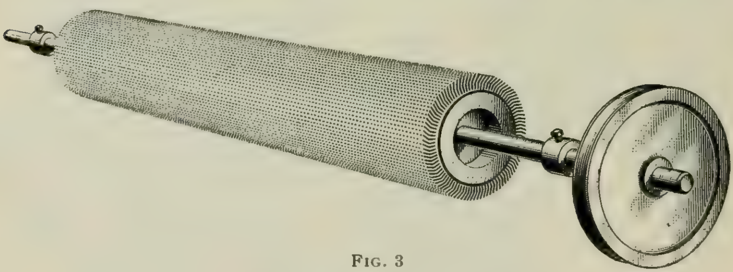


FIG. 3

points projecting toward the operator. The cylinder was slowly turned by hand, after it had been partly uncovered at the front, and the stripping card pressed into the wire of the cylinder and alternately pushed backwards and drawn forwards, the latter movement removing the waste from the cylinder. A similar operation cleaned the waste from the doffer.

A much better method of stripping the card and the one now commonly adopted is by means of a stripping roll, such as is shown in Fig. 3. This roll consists of a wooden cylinder mounted on an iron shaft and having wire clothing wound around it so as entirely to cover its surface, although on some rolls a narrow space without teeth is left from one end to the other. The clothing used for the stripping roll carries a very much longer tooth than that used to cover the cylinder or doffer, and the wire teeth are not set so closely together.

3. Frequency of Stripping.—The number of times that a card should be stripped within a stated period will be found to vary, but it may be said to depend on two factors. One is that the greater the weight of cotton that is put through the card per day, the more frequently it should be stripped; the other is that in fine work the clothing should be kept as free as possible from short fiber and particles of foreign matter, so that when running fine work the card should receive more frequent stripping, notwithstanding the fact that a lighter weight of cotton is being put through the card than in coarse work. It may be stated as a common practice that for fine work the card should be stripped three times a day unless a very large production is being obtained, when it is advisable to strip four or even five times per day, while with a medium production and where a very high grade of work is not called for, it is not necessary to strip the cylinder and doffer more than twice a day.

To stop a card for stripping purposes necessarily means a reduction in the amount of product, but by carefully planning so that the card will not be stopped any longer than necessary before it is stripped, and by getting it in operation again immediately after stripping, the loss can be reduced to a very small amount. In stripping cards two men are usually employed, since one cannot readily handle the long stripping roll; and time can also be saved by having one man preparing the next card for stripping while the other man is performing the operation of restarting the card previously stripped and removing the strippings from the

stripping roll. Since it is the usual practice to strip the cylinder before stripping the doffer, time may also be saved by starting the feed while the doffer is being stripped. In this manner the cylinder will be filled and the sliver will be ready to be pieced up as soon as the stripping action is completed. In order to economize in the amount of strippings removed from the card, the feed-roll and calender rolls should be stopped a short time before the card is stopped, thus allowing the good cotton to run through the card and drop on the floor in front of the doffer; it is then removed and returned to the mixing room.

4. Operation of Stripping.—The operation of stripping is as follows: The card is first stopped by shipping the driving belt from the tight to the loose pulley. The feed-roll should have been previously stopped by disengaging the side shaft m_{12}, Fig. 2, at the doffer, and the gear m_{13}, Fig. 1, should also have previously been thrown out of gear by means of the handle, thus stopping the calender rolls and coiler and allowing the good cotton to run through the card until exhausted, as previously stated. As the cylinder is the first to be stripped, the cover, or door e_9, that protects the cylinder at the front and is hinged on the arms e_{10}, is lowered so as to leave the cylinder bare at that point. The stripping roll is now placed in the upper set of bearings r_1 and a band run from the outer groove of the loose pulley of the card to the grooved pulley on the end of the stripping roll. This band should be crossed in order to give the correct direction of motion to the stripping roll. With the stripping roll in this position its teeth should project a slight distance into the wire of the cylinder, usually about $\frac{1}{8}$ inch, and should point in the direction of revolution of the roll. At the point where the roll is in contact with the cylinder, the teeth of both are pointing in the same direction and the surface speed of the roll is greater than that of the cylinder, thus making the stripping possible. The driving belt of the card is now moved sufficiently on to the tight pulley to turn the cylinder slightly and at the same time leave

enough of the belt on the loose pulley to give the necessary power to drive the stripping roll.

It is advisable for the operator to be able to control the speed of the stripping roll at all times and to stop it suddenly if necessary. On this account the band that runs from the loose pulley to the stripping roll is not usually tight, the stripper creating sufficient tension to drive the stripping roll by pressing his hand on the band. By this means the wire teeth on the rapidly revolving stripping roll remove the waste from the spaces between the teeth of the card wire on the cylinder, this waste adhering to the surface of the stripping roll. In performing this operation, care should be taken that the cylinder does not attain a greater surface speed than the roll, since in this case the excess surface speed of the cylinder will cause the waste to be taken from the roll by the cylinder.

After the cylinder has made one complete revolution, the band that drives the stripping roll is removed and the stripping roll taken from the stands r_1 and cleaned and then placed in lower stands at the doffer, as shown in Fig. 1. A band somewhat longer than the one previously used is then run from the loose pulley of the card to the grooved pulley on the stripping roll r. This band is also crossed, and the operation of stripping the doffer is performed in the same way as that of stripping the cylinder. It is the practice in some mills, especially those making coarse counts, to run the card while stripping the doffer. This, however, is not good practice, since the stripping roll throws out considerable dirt, a good part of which is liable to drop into the web and be carried through into the finished sliver.

5. Cleaning the Stripping Roll.—After stripping the cylinder of each card, and also the doffer, the strippings retained by the stripping roll should be removed from the stripping roll. These strippings may be removed by a hand card or by placing a finger in the narrow space that is without wire teeth, when one is left in the stripping roll, breaking the circular web at this point, and unrolling it from

the roll. Another method of removing the strippings from the stripping roll and one that is used in a large number of mills is to employ a box that is placed on wheels. This box is usually about 18 inches wide, 3 feet deep, and long enough to allow the clothed part of the stripping roll to rest between its ends, while the ends of the shaft rest in **V**-shaped grooves in the ends of the box. A strip of wood about 4 inches wide covered with card sheets is fixed between the ends of the box in such a position below the stripping roll that the wire teeth of the roll will just enter the wire of the sheets when the shaft of the roll is set in the grooves in the ends of the box. When cleaning the roll, it is turned by hand with a backward and forward movement, which causes the strippings to be removed and dropped into the box. This method is quicker and better than the hand card and provides a place for keeping the roll. The box also serves as a receptacle for the strippings.

It will be noticed that a card immediately after being stripped produces a sliver slightly lighter in weight, which is due to the spaces between the teeth of the clothing filling up again with fiber. In mills where it is desired to make exceptionally even yarns it is not advisable to strip at one time all the cards supplying one subsequent machine, but to take them in sections of either two or four supplying different machines.

GRINDING

GRINDING ROLLS

6. Grinding is the process of sharpening the teeth of the card wire on the cylinder, doffer, or flats by means of rolls called **grinding rolls,** and is of great importance in connection with carding. Formerly when mild-steel wire was used grinding had to be performed frequently. The clothing, however, that is almost universally used at the present time is made of hardened-and-tempered-steel wire that is ground on the sides after having been inserted

through the foundation; consequently, the tooth is almost wedge-shaped, so that even when the extreme point is worn away there still remains a comparatively sharp tooth. Grinding is therefore required less frequently than formerly, not only because the hardened-and-tempered-wire retains its point longer, but also on account of the shape of the tooth.

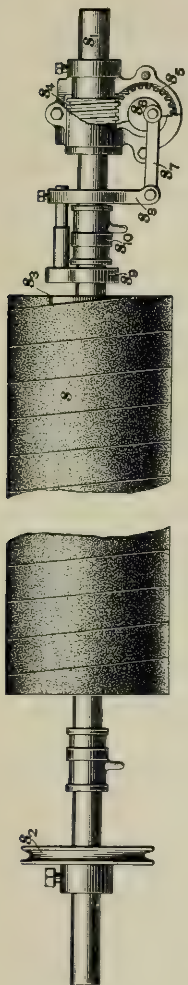


FIG. 4

7. Dead Rolls.—Grinding rolls are of two kinds—the *dead roll* and the *traverse grinder*. The **dead roll** is shown in Fig. 4. It consists principally of a hollow shell s mounted on a shaft s_1. This shell is covered with emery fillet wound spirally on its surface. At the ends of the shell, where the fillet tapers to a point it is passed through slots, one of which is shown at s_3, and is firmly fastened by means of a steel clip setscrewed to the inner side of the shell. A dead roll suitable for grinding purposes on a 40-inch card is about 42 inches long and $6\frac{3}{4}$ inches in diameter.

When grinding, the dead roll is given a slight traversing motion and grinds the back of the teeth with a slight tendency toward grinding the sides. The traversing motion is obtained in the following manner: The shaft that carries the shell s projects beyond both ends of the shell sufficiently to carry at one end the worm s_4 and at the other end the pulley s_2, through which the roll receives its rotary motion; this pulley is driven by a band that passes around the grooved pulley on the end of the cylinder shaft of the card. The worm s_4, which is fast to the shaft s_1, drives a worm-gear s_5 that carries a pin s_6 set away from the center of s_5 and loosely connected to the rod s_7, the other end

of the rod being connected to the bracket s_8, which is loose on the shaft s_1. Connected to the bracket s_8 by means of a short rod is another bracket s_9, that is loose on the shaft s_1. The two brackets s_8, s_9 enclose a brass bushing s_{10} that rests in one of the bearings for the grinding roll when the roll is in position, while a similar bushing on the other end of the shaft rests in the other bearing. Pins on these bushings project into holes provided in the bearings and thus hold the bushings firmly in one position. These bushings are loose on the shaft s_1; consequently, the shaft is free to revolve and also to move laterally. With this construction, it will be seen that as the worm s_4 drives the worm-gear s_5, the latter, acting as an eccentric because of the position of the pin s_6, will tend to impart a reciprocating motion to the brackets s_8, s_9 through the connecting arm s_7, but will be prevented from doing so on account of these brackets being held in one position by means of the bushing s_{10}. Since the brackets are stationary, the rod s_7 and the pin s_6 that connects it with the gear s_5 can have no lateral movement; consequently s_5, by its eccentric movement around s_6, will, through its bearing in the gear-cover, a portion of which is shown broken away in Fig. 4, and through the collars on the shaft at each side of the cover, impart a traversing movement to the shaft s_1 and the roll s. Dead rolls are used for grinding the flats of the card, but seldom for grinding the cylinder or doffer, it being the custom to grind these two parts with the dead roll only when they have been newly clothed or when their surfaces become very uneven.

8. The Traverse Grinder.—The second type of roll, known as the **traverse grinder**, or sometimes as the **Horsfall grinder**, is shown in Fig. 5. It consists of a roll t about 4 inches wide covered with emery fillet and mounted so as to slide on a hollow barrel, or shell, of large diameter. Inside the barrel is a shaft containing right- and left-hand threads connected at the ends. A fork t_1 fits into these threads, and a pin that projects from it passes into

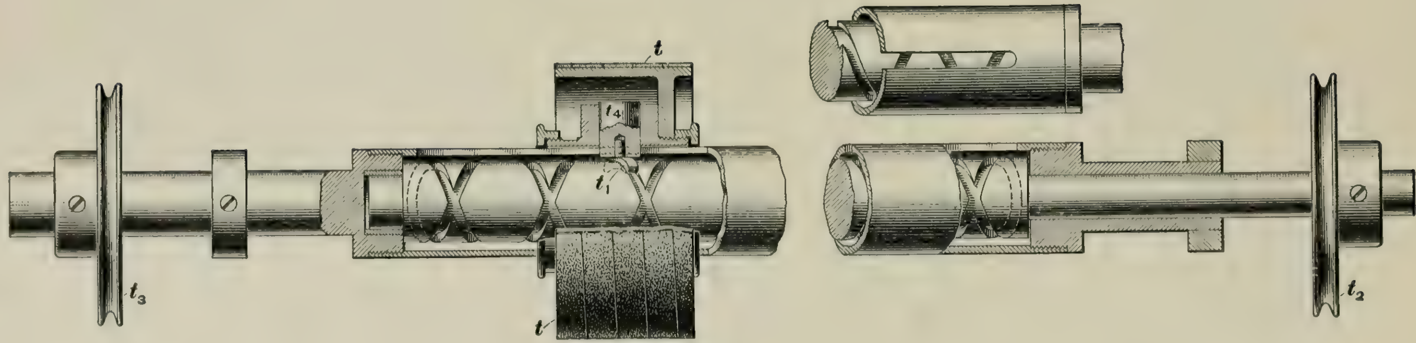


FIG. 5

another pin t_4 that projects into a straight slot in the outer barrel and enters the roll. There are two pulleys, one of which t_2 is on the inner shaft, while the other t_3 is on an extended portion of the barrel. With this construction the barrel is rotated when t_3 is driven; the pressure of the edge of the slot against the pin t_4 when the barrel is revolved causes the grinding roll also to revolve. A traverse motion is also imparted to the roll t by driving the pulley t_2, which causes the fork t_1 to be moved from side to side, changing from one thread to the other at each side of the card. Since the grinding roll presses against the clothing, the result of its traverse motion is to cause the teeth that are in contact with it to be bent, or inclined, toward the side of the card to which the roll is moving. The result of this is that the sides of the points of the teeth are ground down slightly, as well as the top of the points. In consequence of the roll being so narrow, it requires a longer time to grind the card with this mechanism than with the dead roll, other conditions being the same, but the results are so much better that it is very largely used. There is an unavoidable dwell on each side, which tends to grind down the sides rather more than the center; this is the only other important disadvantage in the use of this grinder.

Grinding rolls, whether traverse grinders or dead rolls, are usually covered with emery fillet; this is a tape 1 inch wide covered on one side with emery, and is supplied in lengths of about 300 feet. It can be obtained with emery of different degrees of coarseness or fineness, the kind generally used for card grinding being known as No. 40.

PREPARATION FOR GRINDING

9. All grinding is usually performed by a man known as a **grinder,** who in large mills has from twenty to sixty revolving-top flat cards under his charge. The cards are usually ground in turn, unless some accident or defect necessitates some card to be ground out of the regular order. Before the grinding takes place, however, the card must be

prepared for this purpose, and the operation is somewhat as follows: The lap is either broken off at the back and the end allowed to run through, or more usually the side shaft m_{12}, Fig. 2, is disengaged and the feed-roll turned backwards by turning the plate bevel gear b_5 in the opposite direction from that in which it usually revolves. This rolls up the sheet and takes the fringe of cotton away from the licker. Any cotton in the card is allowed to run through and the cylinder and doffer are then stripped clean of short fibers, care being taken that no cotton remains on the part stripped. The card is then started and the flats allowed to run bare of all strippings; this takes from 25 to 40 minutes, according to the speed of the flats and nature of the cotton being carded. The card is then stopped and the fly taken out from under the card and from between the sides of the cylinder and framework and between the sides of the doffer and framework, where it collects. Card makers have in late years greatly lessened this space and in so doing partly reduced the amount of fly at these points. This waste is sometimes called **cylinder-end waste,** and is removed from these parts by means of a long, thin hook usually made from a bale tie. Fly also collects around the shaft that connects the sprocket gears that drive the flats. Care should be taken to remove all loose fly from around and under the card before grinding is commenced. If any remains there is great danger of fire, as sometimes the grinding roll strikes sparks.

After making certain that the gear m_{13}, Fig. 1, and the side shaft, m_{12}, Fig. 2, which where thrown out of gear before stripping, are well out of contact, disengage the doffer and barrow gears by throwing up the front end of the catch l_4, Fig. 1, which will drop the lever l_5 that supports the barrow gear. The licker belt, flat belt, and comb bands may then be removed. In some cases, when grinding, it is necessary to remove the pulley on the shaft with the worm that drives the flats, in order to accommodate the bands that are placed on the card for grinding, but where this is not necessary the flats should always be run with their driving belt reversed, so that when the direction of rotation of the

cylinder is changed for grinding, as described later, the flats will move in the same direction and at the same speed as when carding. If the flats are stationary during the grinding process they will be filled with dirt by the cylinder, and the first cotton that is put through the card after grinding will have to be considered as waste on account of the unclean condition of the flats.

During grinding, the cylinder is driven at the usual speed but in the opposite direction to that in which it is driven for carding purposes. It is necessary to reverse its direction in order that the back of the tooth may be presented to the grinding roll when grinding. If the front of the tooth were presented to the grinding roll, the tooth would be beveled off at the front, which is directly the reverse of what is desired; in addition to this, the grinding roll acting on the front of the tooth would tend to raise it from its foundation and cause it to stand higher than it should. In order to reverse the direction of the cylinder it is necessary to cross the driving belt, if it was previously open; but if the belt for driving the cylinder when carding was crossed, it is simply necessary to have the belt open when grinding. If it is necessary to cross the belt when grinding it will be somewhat tight; to avoid this it is sometimes the custom to use an extra belt of the right length, which is carried from card to card by the grinder, although the same belt is more often used for both grinding and carding. In this case, if the belt was crossed when carding it must be taken up when used for grinding. This is accomplished by punching two holes in a line crosswise of the belt and two holes similarly placed but a short distance from the first holes and inserting a lacing of horsehide, thus forming a loop in the belt. The distance between these two pairs of holes depends on the amount of slack that it is necessary to take up in order to drive the cylinder with an open belt.

The doffer when being ground is driven in the same direction as for carding purposes, but at a higher speed, by a special belt *u*, Fig. 2, from a pulley on the cylinder shaft. By these arrangements both the cylinder and doffer revolve

with the wire pointing in the opposite direction to the direction of motion.

10. After making sure that everything is clear of the cylinder and doffer and that the belts for driving them are properly adjusted, the card is started. The cylinder and doffer are then brushed by means of a brush about 2 feet long and 3 inches wide, which is held in contact with the cylinder and doffer wire by the operative and moved from side to side of the card, thus removing all dust from the interstices of the wire. The card is then allowed to run a few minutes to remove from the flats the dust that has lodged there when brushing the cylinder and doffer.

Next the card is stopped and the grinder removes such covers and bonnets as are necessary to be removed. The grinding roll for the cylinder is then placed in the stands v, Fig. 2, with the pulley that gives the traversing motion to the roll on the same side as the main driving belt of the card. A band for giving the rotary motion is put on the pulley t_3, Fig. 5, of the grinding roll and around one of the grooves of the pulley e_{16}, Fig. 2, on the cylinder shaft. The grinding roll for the doffer is now placed in position in the stands v_1 in the same manner as the cylinder grinding roll. A band is passed around the pulley t_3, Fig. 5, and around the other groove of the pulley e_{16} on the cylinder shaft.

The pulley t_2, Fig. 5, on the opposite end of the grinding roll imparts the traversing motion to the roll t. A band that passes around the grooved pulley compounded with the tight pulley on the cylinder shaft passes around the pulley t_2 on the doffer-grinding-roll shaft and also over the pulley t_2 on the cylinder-grinding-roll shaft, thus imparting motion to the latter by slight friction only. In some cases an extra pulley is placed on the shaft of the doffer grinding roll and a band passed from this pulley around one of similar size on the shaft of the cylinder grinding roll, thus giving a more positive traversing motion. The former method of imparting the traversing motion to both rolls is not very satisfactory, as the cylinder roll does not receive as positive a

motion as it should, owing to the small portion of the pulley that comes in contact with the band.

It is possible to use one bracket for carrying both the stripping and the grinding rolls, but it is very inconvenient, as the wire of the stripping roll should project a short distance into the wire of the cylinder or doffer, while the surface of the grinding roll should only lightly touch the points of the wire on the cylinder or doffer; consequently, the distance from the center of the shaft to the surface of the roll will be different in each case. Even if the two rolls are arranged at first so that the necessary distances are obtained, the wire on the stripping roll will wear down more quickly than the emery on the grinding roll, and thus it will be necessary to adjust the brackets when changing from one roll to the other. Consequently, it should be ascertained which bracket must be used for each purpose, and in operating the card this fact should be remembered.

OPERATION OF GRINDING

11. Grinding the Cylinder and Doffer.—After having placed the grinding rolls in their stands, and usually before the proper bands are adjusted, the grinder proceeds to set the grinding roll to the wire on the cylinder and doffer. In performing this operation it is generally first necessary to use a card gauge, in order to make sure that neither grinding roll is pressing too heavily on any part of the cylinder or doffer. After this the proper bands are adjusted, the card is started and the grinder determines the actual setting of the grinding rolls to the wire by placing his ear as close as possible to the point at which the grinding roll comes in contact with the wire and judging by the amount of sound that is made whether either grinding roll is in its correct position. In light grinding, which is preferable, only a light buzzing sound should be distinguished, and care should be taken that this is the same at all points on the cylinder or doffer. When setting the grinding rolls, the brackets that support them are adjusted by means of nuts and setscrews provided for that purpose.

During the grinding operation, the grinding roll of both the cylinder and the doffer is rotated at a speed of from 800 to 900 feet per minute; the cylinder is making about 2,150 feet per minute, while a point on the surface of the doffer will move about 1,866 feet per minute in the card under consideration. The direction of the rotation of the cylinder and the doffer, and the inclination of the teeth are such that the grinding roll grinds the back of the teeth. At the same time, because of its traversing motion, it also grinds the sides as has been explained. The grinding roll does not merely touch the wire but produces a slight pressure on it, which tends to force the point of the wire forwards toward the foundation of the clothing; consequently, if the roll grinds on one portion longer than the other, the wire will be lower in this place. This is more liable to occur with the traverse rolls at the edges of the cylinder and doffer, where the rolls have a slight dwell during the reversing of the traverse. If possible this reversing should take place almost beyond the edges of the cylinder and doffer, and grinding stands are now set wide enough to allow a longer roll to be used, which permits the disk to traverse almost off the wire while reversing. After the card is ground, the grinder removes the grinding rolls and brushes out the cylinder and doffer clothing, for the purpose of removing all small pieces of steel or emery caused by the grinding. After stopping the card, the grinder removes the belt driving the doffer, makes the necessary settings, changes the driving belt, and replaces all belts, bands, and parts that were either removed or changed in position to prepare the card for grinding; he then puts on a lap and starts up the card.

The length of time required for grinding depends to a great extent on the condition of the wire, since if the points of the teeth are dulled considerably, a longer time will be required than if the clothing is in comparatively good condition. The degree of coarseness of the emery on the grinding roll also governs to some extent the time required for grinding, since coarse emery cuts much faster than fine

emery. The time required for grinding is also governed by the amount of pressure exerted by the grinding roll on the clothing. If the grinding roll is set so that it presses heavily on the wire, the grinding will be accomplished in less time, although there is more danger of injuring the wire; such grinding is known as *heavy grinding*. If the grinding roll presses only lightly against the clothing, a greater time will be required to secure the proper point on the teeth, but there is less danger of injuring the wire; this method of grinding is spoken of as *light grinding*.

The temper of the wire with which the card clothing is set also affects the length of time required for proper grinding, since hardened and tempered wire grinds more slowly than soft wire.

As a general rule it may be stated that from one-half to one working day, or from 5 to 10 hours, is the usual time required for properly grinding the cylinder and doffer of a card.

The interval between the times of grinding depends somewhat on the product of the card, the condition of the wire, and the opinion of the person in charge. Generally speaking, it is advisable to grind frequently and lightly for a long time rather than at more remote intervals and heavily for a short time, as the former method is not so liable to heat the wire and to take out the temper. If the cards are turning off an average production for medium counts, grinding the cylinder and doffer once in every 20 or 30 days will be found sufficient. In many mills they are not ground so frequently.

12. Grinding a New Card.—A card that has been newly clothed requires grinding before being used for carding purposes, and this first grinding operation will be found to differ somewhat from the usual method of grinding, the object being to render the surface of the cylinder and doffer perfectly level at all points. If the fillet is not put on with a regular tension it is liable to rise, or blister, at places, and if the tacks that hold it have not been driven with care the wires around them will be high. Sometimes the edges of

the fillet are allowed to overlap slightly or the fillet is crowded too closely, thereby causing the wire to be higher in some places than in others. If the card is carefully clothed these faults should not occur to any extent, but when they do those wires that are higher than the others must be ground level with the rest of the surface. A newly clothed card is first ground with dead rolls, which are left on until the surface of the wire on the cylinder and doffer is perfectly smooth; this takes from 3 to 10 days. After the wire has been ground level by means of the dead rolls, the traverse rolls are used for the purpose of putting a point on the wire and are left on about a similar period, the length of time depending on the temper of the wire and also on the length of time that the wire has been ground by the dead rolls.

13. Grinding the Flats.—The card wire on the flats requires grinding periodically, and while some portions of the preceding description and remarks apply to grinding in general and can be applied to the grinding of the flats, there are special features in connection with this process that make it differ somewhat from the grinding of the cylinder and doffer. The fact that the flats are arranged in an endless chain and slide for a portion of their movement on a smooth, circular arc, while at another portion of their circuit they are carried over rolls on which they are suspended, prevents their being driven past the grinding roll at the same speed as the card wire on the cylinder or doffer. On this account and also because there are, during the running of the card, a number of the flats that are performing no actual work for a considerable length of time, it is customary to grind the flats while the card is in operation and with the flats moving at their working speed, which saves a loss of time and production. This slow movement of the flats, since only one flat is ground at a time, causes considerable time to elapse before all the flats can be brought under the action of the grinding roll. The dead roll is almost always used for grinding the flats and is placed in brackets on each side of the card. These brackets are so adjusted that the roll,

when resting in them, will lightly touch the wire of the flats as they pass from the front to the back of the card; that is, it grinds the flats while they are suspended by the bracket over which they move. An arrangement is adopted to firmly support the flat while it is being ground, and at the same time hold it in such a position with relation to the grinding roll that the heel of the flat will not be ground off. When the flats are at work the heel is closer to the card wire on the cylinder than is the toe, and if this relative position

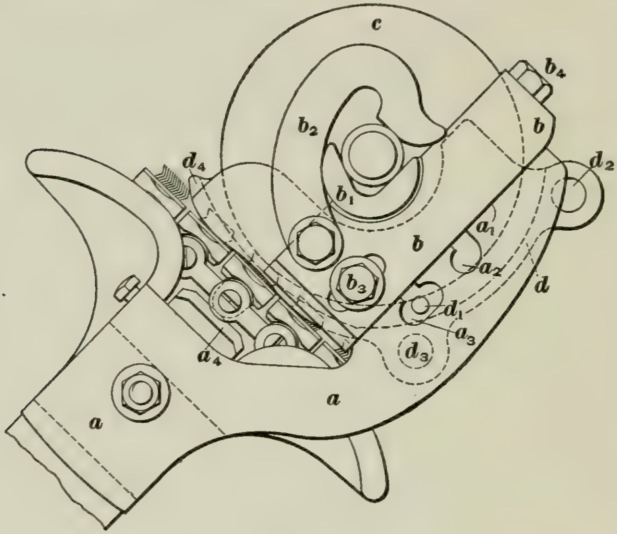


FIG. 6

were preserved with regard to the grinding roll, the wire at the heel would be ground off before the wire at the toe was touched by the grinding roll.

14. One type of grinding apparatus is illustrated in Figs. 6 and 7; Fig. 6 shows the grinding apparatus in position, while Fig. 7 is a perspective view of some of the essential parts. The bracket *a* that supports the different parts is firmly attached to the side of the card, there being a bracket on each side. Resting against the inclined surface a_1 of the bracket *a* is a casting *b* that carries the

bearings b_1 for the grinding roll c. Attached to this casting is a finger b_2 that serves to lock the grinding roll firmly in position. The casting b is firmly secured to the piece d and can be adjusted by loosening the nut b_3 and turning the set nut b_4, thus moving the grinding roll nearer to or farther from the teeth of the flats, as may be desired. A pin d_1 that is carried by d may be set in either of the slots a_2, a_3 cast in the bracket a. At its lower part the piece d carries the **former** d_4, which is so shaped that if it is pressed firmly against the end of the flat, the wire surface of the flat will be presented in such a position to the grinding roll that the flat will be ground evenly across its width. These parts are, of course, duplicated on the other side of the card, and rods that serve to connect the two sides at the points d_2, d_3 extend across the card, the entire mechanism being known as the **cradle.**

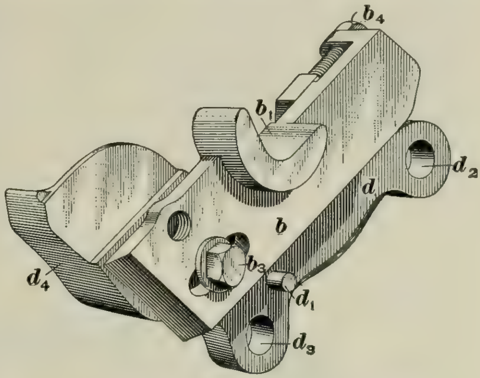


FIG. 7

The parts mentioned form the principal parts of this mechanism and its operation is as follows: When the cradle is in position for grinding, the pin d_1 on d projects through the slot a_3 of the bracket a, but it should be clearly understood that during grinding, d is not supported by the bracket, since the weight of all the parts is made to bear on the ends of the flats, which during this time are supported by the bracket a_4, attached to the bracket a. In this manner, each flat during its movement from the front to the back of the card is brought between the bracket a_4 and the former d_4, against which it will be rigidly held; the former d_4 is milled in such a manner as to cause the flat to assume its correct position in relation to the grinding roll and to be held in this position until it has passed entirely from under the action of

the grinding roll. When this grinding arrangement is not in use it may be raised and the pin d_1 inserted in the slot a_2, thus bringing all the parts out of contact with the flats; or when it is desired, all the parts may be removed to another card for the purpose of grinding.

15. Another device for holding the flats in the correct position for grinding is shown in Figs. 8 and 9; Fig. 8 shows the mechanism as it appears when looking at the side of the card, while Fig. 9 shows certain of the parts as viewed from

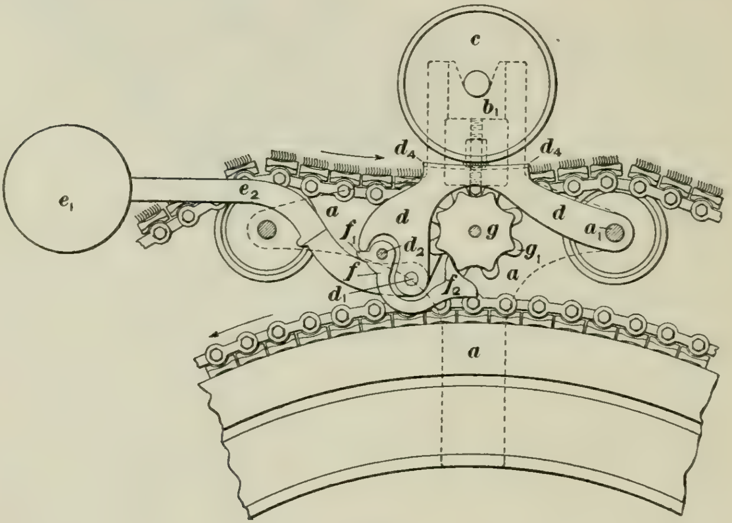


Fig. 8

the inside; consequently, one view is the exact reverse of the other. These parts are duplicated on each side of the card, but as they both work exactly alike only one will need a description. The grinding roll c is placed directly over the center of the cylinder and rests in the bearing b_1 supported by the stand a, which is firmly attached to the framework of the card. In the illustrations, the bearing b_1 and stand a are indicated by dotted lines in order to leave an unobstructed view of the interior parts. Pivoted to the stand a at the point a_1 is a casting d, the upper part of which projects

sufficiently to come directly over the outer ends of the flat, and constitutes the former d_4. If the flat is forced against this projecting piece, or former, the teeth will assume the correct position for grinding. Pivoted to the casting d at the point d_1 is a lever e_2 that carries at its outer end a weight e_1, while the inner arm e of this lever bears against the under side of the flat. Pivoted to the bracket a at the point d_2 is a lever f that carries a shoulder f_1 that bears against a projection on the casting d. At its other end, the lever f has a projecting finger f_2 that bears against the cam g. Compounded with

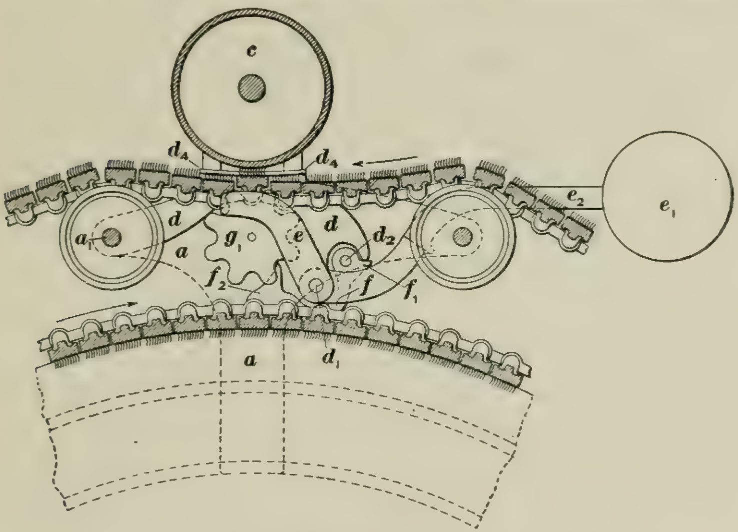


FIG. 9

the cam g is a sprocket gear g_1, the teeth of which engage with the ribs on the backs of the flats.

The operation of this mechanism is as follows: The flats move continuously, the upper line being face up and moving in the direction indicated by the arrow. The movement of the flats causes the sprocket gear g_1 to revolve on its stud, and since the cam g is compounded with the sprocket gear, it will revolve also. The projection f_2 of the lever f is held in contact with the face of the cam by the pressure of the casting d on the shoulder f_1; consequently, as the cam revolves

and one of the high portions of its face comes in contact with the projection f_2, it will force the projection f_2 downwards, and allow it to rise again when one of the low portions of the face of the cam approaches. This movement of the lever f causes the casting d and former d_4 to be alternately raised and lowered to a slight extent.

As the flats move in the direction indicated by the arrow, a portion of the rib of each comes in contact with the upper surface of the arm e, which tends to raise each flat but is prevented from doing so by the former d_4; consequently, the flat is practically locked between these two parts, although its movement in the direction indicated by the arrow is not prevented. As the former d_4 is raised the flat that is thus locked is carried upwards until it assumes its proper position for grinding, which is controlled by the cam g and the former d_4. After the flat has moved sufficiently to be free from the action of the grinding roll c, the former d_4 and arm e are lowered to allow another flat to be brought into position to be raised and ground. This operation is continued throughout the grinding of each flat in the entire set. The lowering of the former and arm allows each flat to be brought into position before being raised in contact with the grinding roll, thus insuring that each flat will occupy its proper position before coming under the action of the grinding roll.

16. Owing to the fact that the flat when performing its carding action is supported at each end only, and also on account of its length being so much in excess of its width, there is a tendency for the flats to bend downwards, or deflect, in the center. The rib forming the back of the flat is so shaped as to reduce the amount of deflection to a minimum, but it cannot be altogether overcome. It will thus be seen that if the flats are ground perfectly level when the wire is upwards, the surface when reversed, that is with the wire downwards in position for carding, will be slightly convex and consequently the ends of the flats cannot be set so close to the cylinder as their centers. To overcome this difficulty and also to avoid dirt and pieces of emery dropping on the

cylinder, which sometimes occurs when the grinding takes place above the cylinder, the flats are sometimes ground in their working position. Such a method is shown in Fig. 10. In this case, the grinding apparatus is placed at the back of the card and the flats are ground with their faces downwards

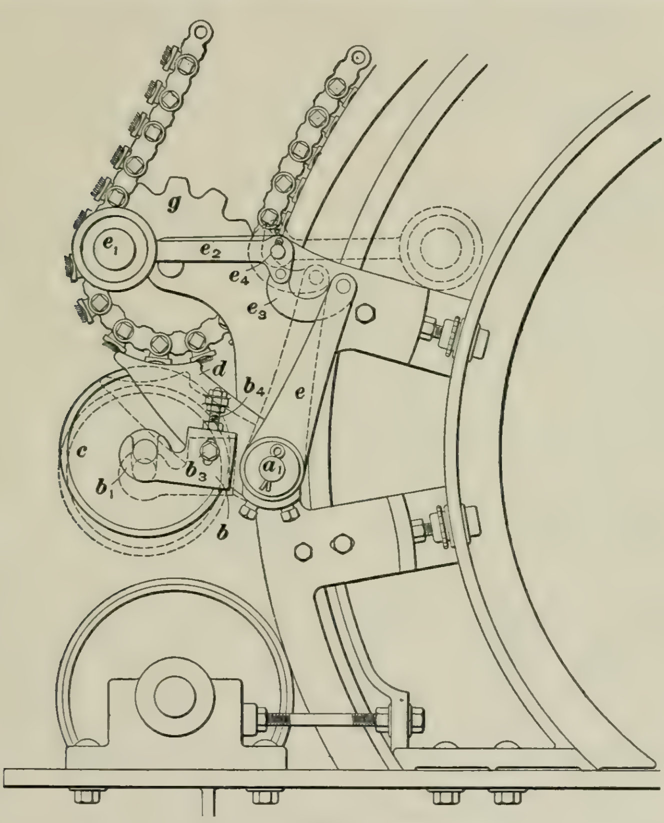


FIG. 10

while in the same relative positions as they occupy when carding. The face of the flat being underneath partly prevents broken wires, pieces of steel, and emery from lodging in the wire and thus being carried around into the carded cotton and incurring the risk of injuring the clothing. The grinding roll c is supported by bearings b_1 that form a

part of the bracket b, which is fastened to the lower part of the former d by means of a setscrew b_3. The bracket that supports the bearings is adjustable and may be altered to bring the grinding roll into its correct position by loosening the setscrew b_3 and turning the adjusting nuts on the setscrew b_4. The upper part of the shoe, or former, d, is so shaped as to give the correct position to the flat, and at its lower end is pivoted on the stud a_1. Pivoted on this same stud and connected with the former, is a lever e that is connected to another lever e_2 by means of the link e_3; the lever e_2 is pivoted at e_4 and carries at its outer end the weight e_1. When the weight is thrown back in the position shown by the full lines in Fig. 10, it raises the former together with the bearings for the grinding roll, causing the former to bear against the end of the flats and thus give each flat the correct position for grinding as it is brought around by the sprocket g. When the grinding apparatus is not in operation, the weight is thrown forwards. By this means the former, together with the bearings for the grinding roll, is lowered, and no part is in contact with the flats. The positions assumed by the different parts when the weight is thrown forwards are shown by the dotted lines in Fig. 10.

The length of time given to grinding the flats varies for the same reasons as those given in connection with grinding the cylinder and doffer, but the intervals between grindings are longer. It is considered sufficient to grind the flats every 4 or 6 weeks. It is advisable, but seldom the practice, for a mill to own a machine for grinding the flats of the revolving-top flat cards. When a mill is in possession of such a machine, it is customary at least once a year to remove the flats from each card and to grind them all to exactly the same gauge, thus insuring that no flat differs from any other in the same card owing to the unequal wear either of the wire or of the ends that rest on the bends.

17. Grinding the Licker.—The licker seldom requires grinding, generally only after an accident has happened to it. When it is necessary to grind the licker, the **solid emery**

or **carborundum wheel** should be used. The licker and wheel are revolved in such a way as to cause the wheel to run against the points of the teeth of the licker. After grinding, the motion of the licker is reversed and the end of a board moistened with oil and sprinkled with powdered emery is pressed against the teeth. By this means the teeth are made smooth. Other methods are sometimes used, such as applying a soft brick or a piece of sandstone to the back of the teeth while the licker is revolving in an opposite direction to its working one.

18. Burnishing.—The card-wire manufacturers supply what is known as a **burnishing brush,** which is now used in some mills. The action of plow grinding or side grinding in the manufacture of wire tends to leave the wire rough at the side, and it is always burnished very carefully before leaving the factory. As it wears down, parts of the wire are reached that have either become rough or were not acted on by the burnishing brush in the manufacturing of the wire. The burnishing brush is therefore used in the mill to burnish the wire on the cylinder, doffer, and flats. It is somewhat the same as the stripping roll, but has absolutely straight wire about $\frac{3}{4}$ inch in length set loosely in the foundation. The brush rests in the stands usually occupied by the grinding roll. It is set into the card wire about $\frac{1}{8}$ inch and makes about 600 revolutions per minute; its outside diameter is 7 inches. It is usually left in operation for a whole day or even longer.

When burnishing the wire on both the cylinder and the doffer it is customary to run them at a very slow speed. This is accomplished in the card under description as follows: A band pulley $14\frac{1}{2}$ inches in diameter having three grooves on its face is compounded with a 20-tooth barrow gear by means of a sleeve. The regular barrow pulley and barrow gear are removed from the barrow stud and the band pulley and gear substituted. The main driving belt runs on the loose pulley, on the edge of which is a groove 20 inches in diameter. In this groove a band is

placed that drives the band pulley on the barrow stud at about 220 revolutions per minute. The additional grooves in this pulley, by means of bands, drive the burnishing brushes. The speed of the doffer by this method is about 23 revolutions per minute, and as it carries a pulley 11 inches in diameter that drives an 18-inch pulley on the cylinder shaft, the cylinder will rotate at about 14 revolutions per minute. The circumferential speed of the burnishing brushes is about six times that of the cylinder.

SETTING

19. The setting of the different parts of the card requires careful attention and is one of the most important points in the management of the card room. Owing to the wear of the wire in grinding and the wearing of the journals of the shafts carrying the cylinder, doffer, and licker, there is a constant tendency for the wire teeth of the different parts of the card to separate and thus increase the distance between their surfaces. This calls for a readjustment of the various parts, which is known as **setting.**

The principal places where setting is required are as follows: between the cylinder and the flats, between the licker and the cylinder, and between the doffer and the cylinder. Other places for setting are between the mote knives and the licker, between the feed-plate and the licker, between the cylinder screen and cylinder, between the licker screen and the licker, between the back knife plate and the cylinder, between the front knife plate and the cylinder, between the flat-stripping comb and the flats, and between the doffer comb and the doffer. In order to determine when these parts require setting, it is sometimes necessary to remove certain covers or bonnets and insert gauges, while in other cases the proper time for setting is determined by examining the work delivered by the card, a method requiring an experienced eye. The intervals at which cards are set vary in different mills, but the parts that contain the clothing are usually set directly after grinding, while the time for setting the other parts is

governed largely by the amount of work done by the card and the stock being used or to be used.

20. Gauges.—The exact setting, or distance between certain parts, of the card is determined by the use of **gauges**; two, and in some cases three, kinds are used. The first one is about 9 inches long and $1\frac{3}{4}$ inches wide and contains four leaves pivoted together. These leaves are made of thin sheet steel and are usually $\frac{5}{1000}$, $\frac{7}{1000}$, $\frac{10}{1000}$, and $\frac{12}{1000}$ inch thick, respectively. The second gauge, which is used exclusively for flat setting, consists of a strip of sheet steel about $2\frac{1}{2}$ inches long and $1\frac{1}{4}$ inches in width bent at right angles about $\frac{1}{2}$ inch from one end, with a handle attached to this end. The other end is the part used for setting and is usually $\frac{12}{1000}$, $\frac{10}{1000}$, or $\frac{8}{1000}$ inch thick. The third gauge consists of a quadrant or semicircle mounted on a shaft and is used for setting the top of the cylinder screen to the cylinder and licker, and also in some cases to set the licker screen to the licker. The curvature of this gauge corresponds to the curvature of the licker. Card gauges are spoken of in the mill as being of a certain number, thus a gauge $\frac{7}{1000}$ inch thick is termed a No. 7 gauge, while a gauge $\frac{10}{1000}$ inch thick is termed a No. 10 gauge.

Since the leaf and flat gauges are very thin, they are easily damaged, and in this condition are of little use, producing faulty settings; consequently, great care should be used to prevent the faces becoming dented, bent, or injured in any way. As the efficiency of the card depends on the proper settings, it will be seen that any defect in the gauge will injure the quality of the production of the card. In many cases poor work results from faulty settings or poor gauges.

21. Setting the Flats.—In order to make it possible to set the teeth of the flats the required distance from the teeth of the cylinder it is necessary that some means be adopted by which the flats may be raised or lowered as desired. The manner of accomplishing this will be found to differ on different makes of cards; one method is shown in

Fig. 11. In this figure a portion of the cylinder *e* of the card, the arch *g*, and the flats *f* supported by the flexible bend *h* are shown. It should be understood that there is a flexible bend similar to *h* on the other side of the card and that the ends of the flats rest on this bend in a similar manner to that shown in Fig. 11. The bend *h* is supported by brackets, which in some cases are composed of two parts h_1, h_2. In

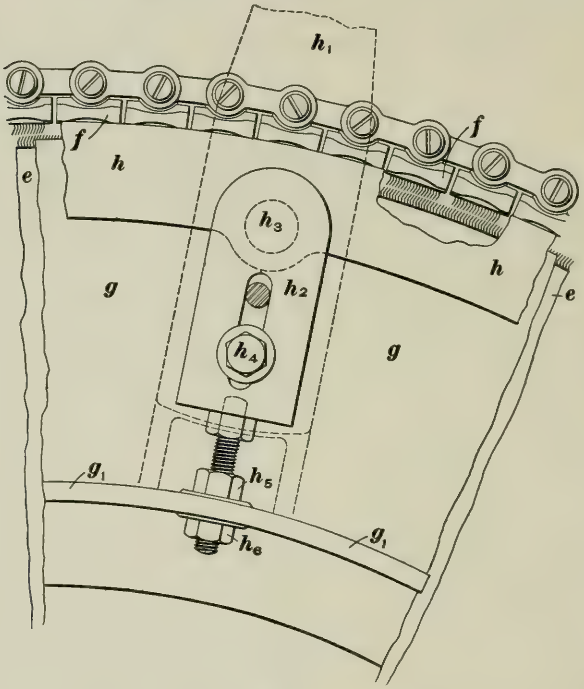
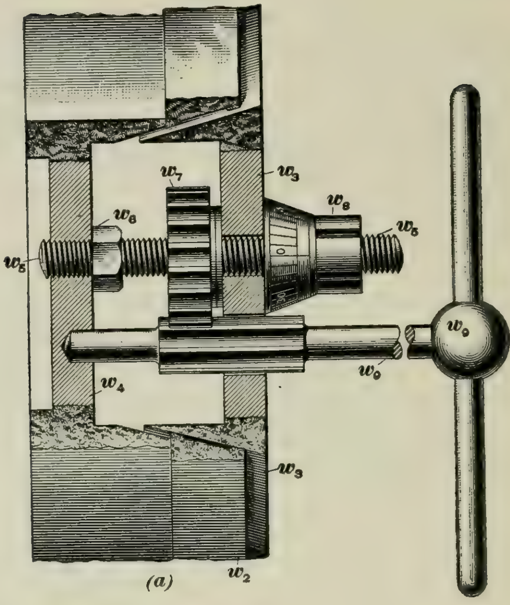


Fig. 11

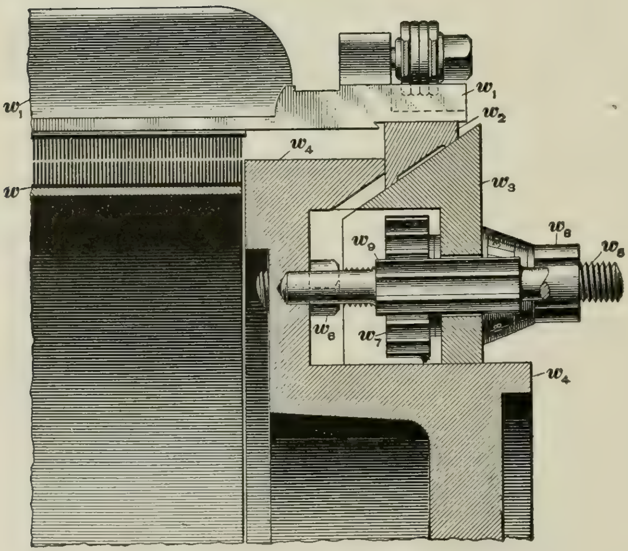
Fig. 11, the outer portion h_1 is shown in dotted lines. The inner portion h_2 is so made that a projecting lug h_3 fits into a hole in the bend and securely holds it in position. The part h_2 is supported by a screw that passes through the rib g_1 of the arch and carries two set nuts h_5, h_6, one above and one below the rib. The bracket is also further held in position by means of the screw h_4, which passes through a slot in the bracket and enters the arch of the card. It is by

raising or lowering the bend h by means of the bracket h_2 that the flats are raised or lowered as desired. There are five of these brackets on each side of the card, and when setting the flats care should be taken that all the brackets are properly adjusted. When setting the flats, the screw h_4 and nut h_6 are loosened and the flats raised or lowered by turning the nut h_5 either down or up, respectively. After the flat has been set in the desired position, the screw h_4 and the nuts h_5, h_6 are firmly secured, thus holding the bracket and bend securely in their proper positions.

22. Another arrangement for setting, or adjusting, the flats is shown in Fig. 12 (*a*) and (*b*), of which (*a*) is a plan view, partly in section, and (*b*) a sectional elevation. The flats are supported by the flexible bend in the usual manner, but the method of supporting the flexible bend is a radical departure from the one just described, the only resemblance being that both have five setting points on each side of the card. The shell of the cylinder covered with fillet is shown at w, while w_1 represents the flat, which is supported by the flexible conical bend w_2, and this in turn is supported by the rigid conical bend w_3 instead of brackets. The bend w_3 rests on the arch w_4 of the card. It can be seen by referring to the figures that the under surface of the flexible bend is beveled and rests on the beveled surface of the rigid bend; consequently, when the bend w_3 is forced in toward the cylinder the bend w_2 must rise, while on the other hand if w_3 is forced outwards the bend w_2 must fall, thus raising or lowering the flats as may be desired. The bend w_3 is operated by a screw w_5 that projects through this bend into the arch of the card and is held in place by the binding nut w_6. On the inner side of the bend w_3 is a toothed nut w_7 that serves as a binding nut and also as a device for forcing the rigid bend away from the cylinder. On the outer side of the bend is a nut w_8 that serves as an index nut, a binding nut, and also as a device for forcing the rigid bend in toward the cylinder. The toothed nut w_7 is operated by a key w_9 that has a fluted, or toothed, portion to fit the teeth of the nut w_7.



(a)



(b)

FIG. 12

When it is desired to lower the flats, or set them closer to the cylinder, the key w_8 is inserted in a hole in the rigid bend and engages with the teeth of the nut w_7. The index nut is moved out on the screw and then the toothed nut is tightened by means of the key, thus forcing out the rigid bend and binding it firmly in position. When it is desired to raise the flats, the toothed nut is loosened and the index nut moved in, thus forcing the rigid bend in until the desired position is reached, after which the toothed nut is again tightened. The index nut is provided in order that the person making the adjustment may tell at a glance just how far the flats are moved.

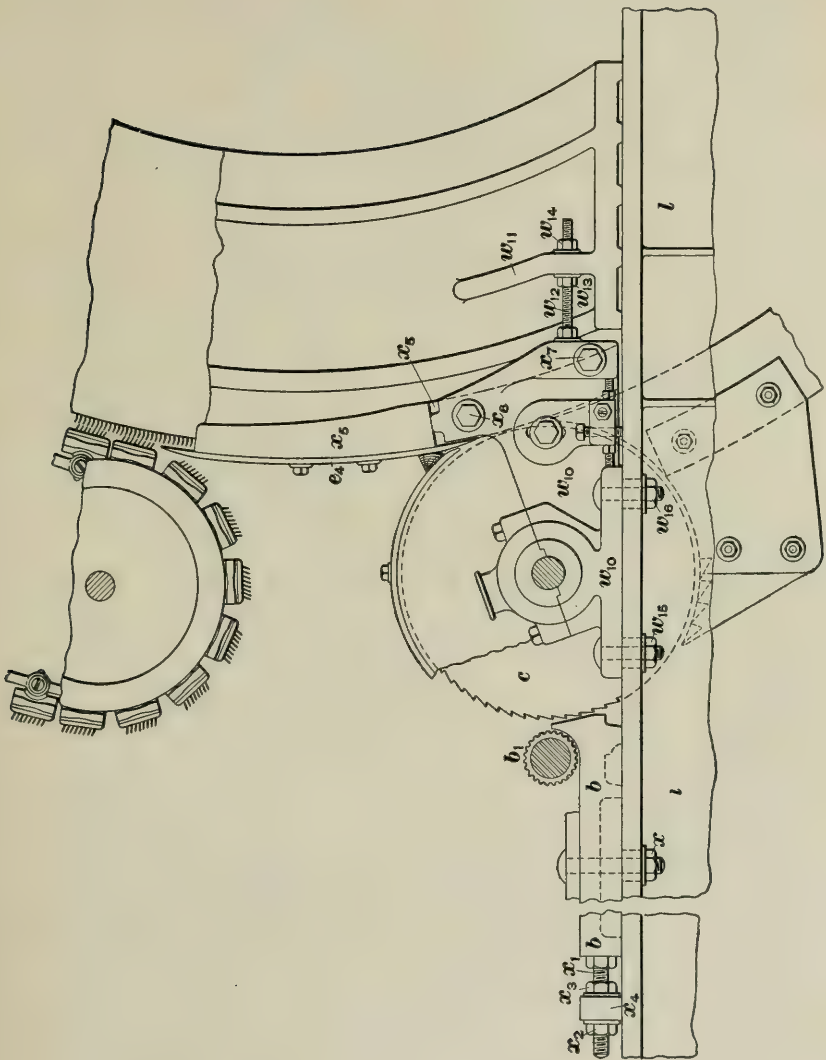
23. The flats are set by means of the flat gauges described, while the card is stopped, and preferably when other machinery in the room is also stopped, so as to prevent any vibration of the floor. In order to provide a blank space in which to insert these gauges, it is necessary to remove certain flats from the chain of flats above the cylinder. Two methods of removing these flats are followed, depending on the method of setting that it is intended to adopt. In those cards constructed with five setting points on each side of the card, it is common to use five flats for setting purposes, a flat being selected that stands almost immediately above each setting point. The flats on each side of the setting flats, as they are called, are removed, making it possible to slip in a gauge on either side of the setting flat; thus, there are ten flats in all removed. A short shaft carries the worm-gear f_{12} and the worm f_{13}, Fig. 2, through which the flats are driven; on this shaft a crank is placed and used to turn the flats while setting. By means of this crank the flats are turned until each of the five setting flats comes directly above a setting point, and they remain in that position until the setting of the flats is completed.

Another method is to remove a flat on each side of one setting flat only, or sometimes two setting flats. This gives but one or two flats that are used for setting purposes, and as there are five setting points on the flexible bend, the chain

of flats must be turned several times in order to bring these setting flats directly over the places where the gauges are inserted. Advantages are claimed for each system, but on the whole there is less work and quicker setting when using five setting flats.

The side of the flat used for setting purposes is the *heel*, which is the side nearest the wire on the cylinder, being about $\frac{3}{100}$ inch nearer than the *toe*. Having brought the setting flats into the correct position over the setting points, the gauge is inserted first between the flat and the cylinder above the central setting point, and the proper adjustment made, as has been described. In setting a flat it is only possible to set one end at a time. The end that is being set, however, should be held firmly in position on its bearings with one hand while the gauge is moved back and forth across the card between the flat and the cylinder with the other hand. Owing to the width of the card it is impossible to move the gauge the entire length of the flat; consequently, one side is set temporarily and then the other side is set in a similar manner, after which the first side set should be tested and also the second side set to make sure that the flat is in the proper position. When both ends of the central flat have been set, the flat at the extreme front of the card is usually set next, at both ends; then both ends of the flat nearest the rear of the card are set, and then the two intervening flats. In setting flats there should be a certain amount of friction, or resistance, felt when moving the gauge along between the flat and the cylinder.

The settings mentioned are only temporary settings, and after the adjustment of the flats the brackets should be secured and the settings again tested, in order to make sure that the proper spaces exist between the cylinder and the flats. The cylinder should now be slowly revolved, the flats at the same time being moved, and if any rustling sound is heard it is an indication that the wire surface of the flats is coming in contact with the wire surface of the cylinder at some point, in which case the flats should be set farther from the cylinder at that point.



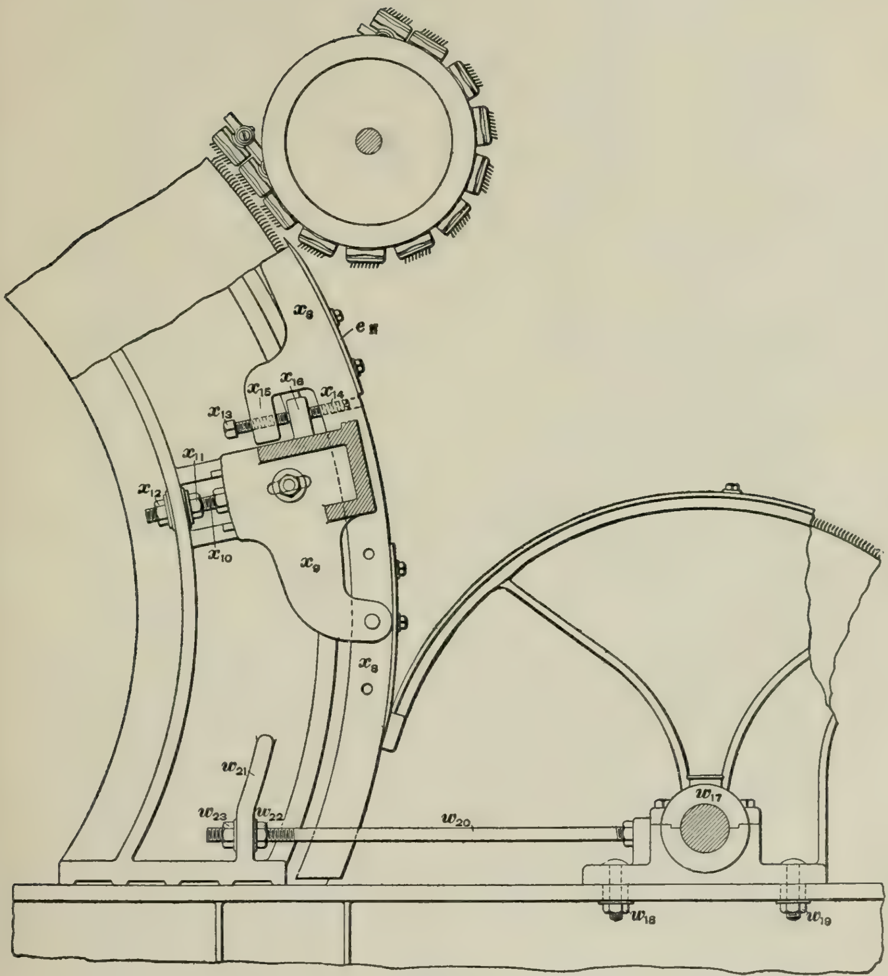
w_{14}
w_{11}
w_{12}
w_{13}
l
x_8
x_7
x_6
x_5
e_4
w_{10}
w_{16}
w_{10}
w_{15}
c
b_1
b
l
x
b
x_1
x_3
x_2
x_4

FIG. 13

The flats are usually set about $\frac{10}{1000}$ inch from the cylinder at the heel of the flat. The flats at the front of the card should be set the closest to the cylinder, while the space between the flats and the cylinder should gradually increase toward the back. If a No. 10 gauge is used, the flats at the back are set loosely to the gauge; those at the top and center, a little closer; while those at the front are set still closer.

24. Setting the Licker.—The licker is mounted on movable bearings w_{10} resting on and secured to the framework, or base, of the card as shown in Fig. 13. There is a lug w_{11} on the arch of the card, through which an adjusting screw w_{12} for adjusting the licker to the cylinder is passed. By loosening the nuts w_{15}, w_{16}, which securely hold the bearing to the framework, and by operating the adjusting nuts w_{13}, w_{14} on the adjusting screw w_{12}, the licker may be moved nearer to or farther from the cylinder, as desired. The leaf gauge is used for this setting and the licker is generally set to the cylinder with a No. 10 gauge.

25. Setting the Doffer.—The doffer is also mounted in movable bearings w_{17}, Fig. 14, which rest on the framework of the card and are securely fastened to it by the bolts and nuts w_{18}, w_{19}. An adjusting screw w_{20} connects the bearing of the doffer with a lug w_{21} on the arch of the card. When it is desired to set the doffer, the nuts w_{18}, w_{19} are loosened, and the doffer can then be set to the desired position by means of the adjusting screw w_{20} and the nuts w_{22}, w_{23}. The doffer is usually set to the cylinder with a No. 5 or No. 7 leaf gauge by inserting the gauge between the doffer and the cylinder where they are in closest proximity. When a No. 7 gauge is used, the doffer is usually set tight to the gauge. After attaining the proper distance between the doffer and the cylinder, the nuts w_{18}, w_{19} are tightened, as well as the adjusting nuts w_{22}, w_{23}. The position of the doffer with relation to the cylinder is an important matter and should receive careful attention. If the doffer is set too far away from the cylinder, a patchy or cloudy web will result, owing to the doffer not taking



x_8
e_8
x_{16}
x_{15}
x_{14}
x_{13}
x_{11}
x_{12}
x_{10}
x_9
x_8
w_{21}
w_{23}
w_{22}
w_{20}
w_{17}
w_{18}
w_{19}

FIG. 14

the fiber from the cylinder regularly and thus allowing the wire of the cylinder to fill up.

The mote knives are carried by two brackets, one at either end, and can be adjusted in regard to the relative distance between their blades and the surface of the licker as described in connection with the construction and operation of the various parts of the card. These knives are set to the licker by means of the leaf gauge and the number of the gauge varies from 12 to 17.

26. Setting the Feed-Plate.—The feed-plate b rests on the frame of the card, as shown in Fig. 13, and is fastened to it by means of the bolts and nut x. When it is desired to set the feed-plate b to the licker c, the nut x is loosened and the plate moved nearer to or farther from it by means of the adjusting screw x_1 and the nuts x_2, x_3. The screw x_1 passes through a lug x_4 on the framework of the card and into the feed-plate. The leaf gauge is also used to make this setting and is inserted between the licker and the face of the feed-plate. The number of the gauge varies from 12 to 20.

27. Setting the Cylinder Screen.—The cylinder screen is made in two sections in the card under description and these sections are fastened together by two staple-shaped bolts, one on each side of the card. These bolts pass through the framework of the card near the floor. Inside the framework of the card on each side is a thin metal arch adjusted so as to be in close proximity to the end of the cylinder. When the screen is in position, it is between, and attached to, these arches, thus forming a casing for the lower portion of the cylinder. The screen is held in position by a number of bolts passing through the side arches of the screen. There are a number of slots in the circular arches of the screen through which the gauge can be inserted in order to obtain the proper distance between the cylinder and the screen.

The nuts on the bolts that hold the screen in position are on the outside of the arches. When it is deemed necessary to set the screens, the doors on the sides of the card are removed to give access to the nuts on the bolts and to allow

a gauge of the proper thickness to be inserted in any of the slots of the screen arch. The screen is raised or lowered to the proper position as determined by the gauge and the nuts are then tightened, thus holding the screen in position. The screen is set farther from the cylinder at the front than at any other point, the distance being about .25 inch, while the screen at the center and back is set about .032 inch from the cylinder. This arrangement prevents the ends of the fibers that have been thrown out by centrifugal force from coming in contact with the front edge of the screen and thus being removed from the cylinder as fly.

28. Setting the Licker Screen.—As the licker and cylinder screens are very close to each other at their nearest point, and as the front end of the licker screen must be set only a short distance below this point, it is nearly impossible to make an accurate setting with the licker in position. The best method is to remove the licker and use a quadrant gauge, the curvature of the outside surface of which should correspond exactly to the curvature of the surface of the licker. This gauge is mounted loosely on a shaft of exactly the same bore as the licker shaft. The ends of the shaft rest in the licker bearings and the screens are set to the proper distance from the quadrant gauge by sliding the quadrant along the shaft. The front edge of the licker screen at the point where it is hinged to the cylinder screen is usually set about .011 inch from the licker. The nose, or portion of the licker screen with which the fibers first come in contact, is set $\frac{1}{32}$ to $\frac{1}{8}$ inch from the teeth of the licker, according to the amount of cleaning action desired at this point and the staple of the cotton being used. Setting the screen farther from the licker at the nose than at the front allows the fibers to be drawn gradually into a more compact space and presents a more even layer of fibers to the action of the wire on the cylinder.

29. Setting the Back Knife Plate.—The back knife plate e_4, Fig. 13, extends from the licker cover, or bonnet, upwards to the flats and corresponds in curvature to the

curvature of the cylinder. This plate is fastened to a circular bend x_5 by means of two screws at each end, and the bend is attached to the adjustable bracket of the licker by means of two setscrews x_6, x_7; consequently, when the licker is adjusted the back knife plate is adjusted, or it can be adjusted independently by means of the setscrews x_6, x_7. The plate is set to the cylinder to about a No. 17 leaf gauge at the lower edge and a No. 32 at the upper edge. This allows the fibers to free themselves and stand out a little from the cylinder before coming in contact with the flats.

30. Setting the Front Knife Plate.—The front knife plate e_{11}, Fig. 14, extends from the cylinder door above the doffer to the point where the flats first leave the cylinder. The amount of flat strippings depends to a great extent on the setting of this plate. The plate is fastened to a circular bend x_8 by means of two screws at each end, and can be adjusted by means of the bracket x_9, the adjusting screw x_{10}, and nuts x_{11}, x_{12}; or it can be adjusted to a certain extent by the setscrews x_{13}, x_{14}. The screw x_{13} passes through an arm x_{15} of the circular bend x_8, while both screws x_{13}, x_{14} come in contact with the arm x_{16} of the bracket x_9; thus by loosening one screw and tightening the other the plate can be adjusted. The front knife plate is also set with the leaf gauge, its distance from the cylinder at the lower edge being about .017 inch. The space between the upper edge of the plate and the cylinder depends on the amount of waste that it is desired to remove as flat strippings, but the usual setting is about .032 inch. If the plate is set farther from the cylinder, more and heavier strippings will be made, and if moved too far away, the strips will form one continuous web instead of being connected by merely a few fibers. If the plate is set too close, some of the short fibers and dirt removed from the cotton by the flats will in turn be taken from the flats by the knife and carried around by the cylinder, thus producing bad work.

31. Setting the Stripping Comb.—The flat stripping comb is mounted on two arms, as described in connection

with the construction and operation of the various parts of the card. There is one nut on each side of the comb at each end. The comb is set by adjusting the nuts on the arms when it is at the lowest part of its swing, with its teeth opposite the toe of the flat. Sometimes it will be necessary to try two or three flats before the comb is set in its proper position. The distance between the toe of the flat and the comb is determined with the leaf gauge and is usually about .007 inch; although this setting should be close enough to allow the comb to remove the strippings from the flats, it should not be so close that the comb will strike the wire and damage it.

32. Setting the Brush and Hackle Comb.—The brush for stripping or brushing out the dust, etc., from between the interstices of the flats is set so that the ends of the bristles do not quite reach the foundation of the fillet on the flats. The brush has longer bristles near its ends, in order to brush the ends of the flats where they rest on the flexible bends, so as to keep them clean and preserve the accuracy of the settings.

The hackle comb is set so that the needles, or teeth, of the comb project for a short distance into the bristles of the brush, in order that all the waste may be removed from the brush.

33. Setting the Doffer Comb.—The doffer comb is set in a manner similar to that in which the doffer and licker are set. The comb is mounted on sliding bearings fastened to the framework, or base, of the card by means of bolts. A setting screw is fastened to the bearing of the comb at each side and passes through a lug that is fastened to the framework of the card. When it is desired to set the comb, the nuts on the bolts that attach the bearings to the framework are loosened and the comb drawn nearer to or farther from the doffer by means of the adjusting nuts on the setting screws, as described in connection with the setting of the doffer and feed-plate. When the proper distance is obtained, all the nuts are tightened. The comb is usually set to the

doffer at the point where they are in closest proximity with a No. 7 leaf gauge.

The doffer comb, in addition to being adjustable as to its distance from the doffer, is adjustable as to the position of its stroke, which is changed by altering the relative positions of the comb and the eccentric from which it receives its motion. If the web should follow the doffer instead of being removed by the comb, the position of the stroke should be lowered; while if the web sags between the doffer and the trumpet, as it sometimes does, owing to atmospheric changes, etc., the position of the stroke should be raised.

The settings given are used only as a basis. The settings of the various parts of the card vary according to the stock being used, the quality and kind of finished work, and the opinion and judgment of the superintendent or overseer in charge.

It is sometimes desirable to make a setting for which there is no gauge of the proper thickness at hand. In such cases it is customary to use in combination two or more of the leaves of the leaf gauge; for instance, if it is desired to set the mote knives to the licker with a 17 gauge and no such gauge is available, the 10 and 7 leaves of the leaf gauge can be used together.

MANAGEMENT OF ROOM

34. In the management of cards many points should be watched, but more especially those that have for their objects: (1) the production of good work; (2) turning off as large a production as is consistent with the quality of the work required; (3) economy by avoiding unnecessary waste and keeping down the expenses of wages, power, supplies, etc.; (4) maintaining the machinery in good condition.

35. Quality of Production.—With reference to the first requirement, it may be said that good work is usually judged by examining the web from the front of the doffer. By withdrawing a portion of it as the card is running and

holding it to the light, the foreign matter and also the neps remaining in the cotton can be observed. If it is the opinion of the overseer that from the grade of stock being used and from the speed of the card such work is not sufficiently good, the card should be examined to ascertain whether it requires grinding or setting. An allowance should be made if the card is examined just before the time for stripping, as at that time the card wire is usually so full of dirt that more or less necessarily passes through, although this is to some extent an indication that stripping should be performed more frequently. In order to test whether wire requires grinding, or in other words whether it is sufficiently sharp to do its work, it is customary to rest the fingers of one hand on the face of the wire when the card is stopped and by drawing the thumb against the points judge of their sharpness by the amount of resistance that is felt. Dull wire allows the thumb to pass with the least resistance. Should the wire show a glistening surface or appear bright on the end of each point, it may generally be considered dull, although this is not an infallible test, owing to the direction in which the light strikes the wire.

The cotton should leave the doffer in a level sheet, free from cloudiness and having good sides. The intermittent clouded effects and flock sides formerly so common are not met with so frequently in revolving flat cards. Sometimes these defects are caused by cotton lodging in some part of the card, more especially in connection with the screens or at the point where the cylinder and the doffer meet, until there is sufficient to be pulled through in one lump by the wire. Another test is to examine the fly underneath the card and if it is found to contain an appreciable amount of good fiber, it indicates that the screens need adjusting. In case of the feed-plate, and more especially where two feed-rolls are used instead of a feed-plate and a feed-roll, plucking sometimes occurs and causes a cloudy effect. Cotton lapping on the doffer instead of being stripped off by the comb is troublesome, more especially when the rooms are allowed to get cold during frosty weather.

36. Quantity of Production.—The second point of management is that of obtaining as large a production as possible. This can be obtained by reducing to a minimum the time when the card is stopped for stripping, grinding, or setting, also by the attendants putting on the new lap as soon as the old one has run off and by not allowing the card to remain stopped on account of the end having broken down in front. When these economies of time have had attention, the only other method of increasing the production is to speed up the card, which is usually done by increasing the size of the barrow gear. The increase in the speed of the doffer is in direct proportion to the increase in the size of the gear. There are many cards at work producing 1,000 pounds per week of 60 hours, and the production of a card varies from this down to 200 or 300 pounds per week. A good speed for American cotton when intended for 32s yarn, carding 800 pounds per week, is about $12\frac{1}{2}$ revolutions per minute of a 24-inch doffer for a 60-grain sliver. When carding Egyptian cotton intended for 60s to 90s yarn and carding about 500 pounds in a week of 60 hours, a good speed for a 50-grain sliver is about 10 revolutions per minute. With sea-island cotton intended for yarn finer than 100s, carding 250 to 300 pounds per week and producing a 35-grain sliver, a good speed for the doffer would be about $6\frac{1}{2}$ to 8 revolutions per minute. With a 27-inch doffer the number of revolutions would be proportionally smaller. The maximum average stoppages during a week for stripping, grinding, cleaning, and all sundry repairs around the card ought not to exceed 10 per cent., and with care this might be reduced to $7\frac{1}{2}$ per cent.

37. Economy.—The third point in the management of card rooms is that of economy; this is most important in respect to the amount of waste produced. The largest percentage of waste in any part of a card is in flat strippings and amounts to about $1\frac{1}{2}$ per cent. The next is the amount of fly from beneath the licker and cylinder, amounting to an average of 1 per cent. The cylinder and doffer strippings

together amount to about $\frac{3}{4}$ per cent., making a total loss at the card of about $3\frac{1}{4}$ per cent., or somewhat over $3\frac{1}{2}$ per cent. if the card sweepings are taken into account. No allowance is here made for the unavoidable loss in the weight of the cotton due to its drying in the hot card room. For fine yarns or particular work these figures may be increased, and for coarse yarns and inferior product, decreased.

In order to secure economy in the flat strippings the front plate should be set in such a manner that the flats will not take out any good cotton. When it is set otherwise, the strippings from the flats seem to be connected by a thick film of good cotton that is generally sold together with the strippings as waste. As previously described, this film can be reduced until the strippings cling together by means of a few fibers only. Beyond this point the only method of reducing the amount of flat strips is to lessen the speed at which the flats move, although this is not advisable, as it deteriorates the quality of the work by not removing so much foreign matter from the cotton. The flats will also be connected by a thick strip of cotton if the heel and toe are not preserved in grinding. The principal method of reducing the percentage of the cylinder and doffer strippings is to reduce the number of strippings, which is undesirable unless it is desired to lower the quality of the work. The fly beneath the card can either be increased or decreased according to the style and setting of the screens under the card and the setting of the mote knives. Tests have been made with cards without screens and it is found that they make about ten times as much fly as cards with screens. Both the knives and the triangular bars that form the screens should be so arranged that they will give free passage for any dirt that tends to lodge there and also to allow the ends of the fibers to be combed or brushed over the edges of the knives, but the spaces between the bars of the screens should not be so large as to allow the fibers themselves to be driven through.

38. Proper Care of Machinery.—The fourth point in the management of cards, namely, keeping the machinery in

good condition, necessitates first of all proper oiling. All parts of the card that are in contact with swiftly moving parts, such as the mechanism in the comb box, the cylinder-shaft bearings, and licker-shaft bearings, should be oiled twice daily; certain other parts that do not revolve so rapidly, for instance the doffer, calender-roll shaft, side shaft, coiler, and all idler pulleys and gears, should be oiled daily; while once a week, generally Monday morning, every moving part of the card should be oiled. Cylinder, licker, and doffer bearings should be filled with tallow, having a small hole in the center so that it will allow the oil to run directly on the shafts and provide a reserve of lubrication that will melt in case of a hot bearing. In oiling the bearings of the doffer and cylinder, care should be taken not to allow the oil to get on the heads of the cylinder or doffer, since in this case it is apt to come in contact with and spoil the clothing. Care should also be used in oiling the traverse grinder that the oil does not fly on to the clothing.

The cards should be kept free from fly and dust and it is usually the custom to clean them after the stripping process. An opportunity should be given at least once a week, usually on Saturday morning, for the cards to be stopped 2 hours for cleaning purposes, at which time a more thorough cleaning is given to all parts than can be given while the cards are running. About once a month the coiler should be taken apart and cleaned, the feed-roll taken out and cleaned, the licker picked free of all foreign substances, and all belts carefully looked over. The belts should be cleaned and dressed as often as it is necessary. Fly from under the card is generally removed twice a week, and any cotton or fly attached to the screens should be picked or brushed off at the same time. The roll on which the lap rests should not be allowed to wear too smooth, but should be painted with some rough composition, such as paint mixed with sand, that will give it a rough surface and prevent the slipping of the lap. The cylinder and licker screens should be taken out periodically and cleaned, a good practice being to polish them well with black lead, which makes them dry and smooth.

The inside faces of the front and back knife plates and the bonnets of the doffer and licker should also be polished with black lead.

After disturbing the settings of a card in any way, the cylinder and licker should be turned around by hand to make sure that there are no parts rubbing. After setting or grinding, and whenever there has been occasion to loosen screws, nuts, or other parts of the card, these parts should all be gone over to make sure that they are tight before starting the card.

39. The speeds of the different parts of the machine are taken by a **speed indicator.** The doffer, however, has so few revolutions per minute that its speed can be ascertained by watching a point on its circumference and counting the number of revolutions it makes.

There should be only sufficient draft between the lap roll and feed-roll, the doffer and the bottom calender roll, the bottom calender roll and the calender roll in the coiler to take up any slack that may occur between these parts. Any excessive draft causes the sliver to be unevenly drawn, thus making thick and thin places in the yarn.

DRAWING ROLLS

COMMON ROLLS

BOTTOM ROLLS

1. Introduction.—The principle of roll drafting is the most important feature of parallelizing and attenuating machinery and in the production of good yarn. Therefore, the construction of *drawing rolls* and various points pertaining to them justify a detailed description. **Drawing rolls,** of which there are two kinds—*common* and *metallic*—are placed in pairs one above the other, the lower ones being driven positively by means of gears; the upper ones, when common, are driven by frictional contact from the bottom rolls, while those that are metallic are driven positively, as will be described later.

2. Construction.—Fig. 1 shows a set of **common rolls** consisting of three pairs, *a* being a bottom roll and a_1 a top roll. The bearings of the bottom rolls rest on stands *b* that are bolted to the roll beam *c*. The construction of the bearings for the rolls and the method of adjusting them in order to obtain the desired distance between any two pairs is fully explained in later pages. Fig. 2 shows a cross-section of the bottom roll *a*, Fig. 1. These rolls are almost always constructed of steel, and are fluted; that is, grooves are cut lengthwise in the surface of the rolls at certain intervals. These flutes aid the bottom rolls in obtaining a better grip on the cotton as it passes between them and the top rolls. The grooves, as shown in Fig. 2, are not perfectly

wedge-shaped, nor do they end in a knife edge, although the face of the roll carries almost a square corner on each side of a flute. A groove is a little less in width at the bottom

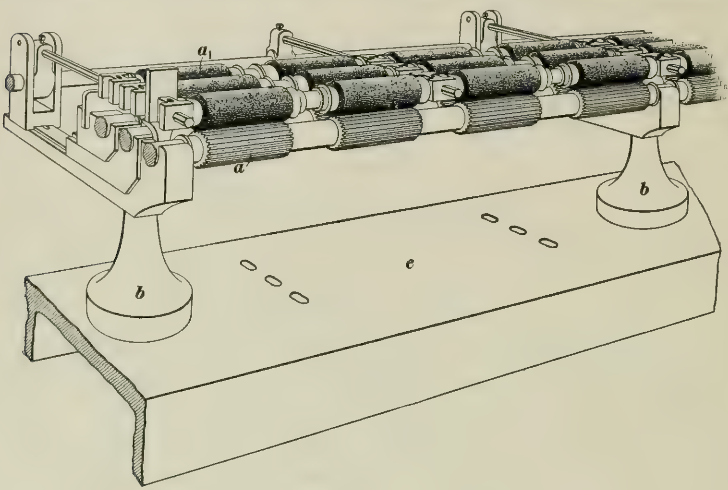


FIG. 1

than at the top, while the number of flutes for the various rolls increases with the diameter of the rolls and with the fineness of the work for which the machine is intended. For example, a roll $1\frac{1}{8}$ inches in diameter will contain more flutes than a roll 1 inch in diameter, while a roll intended to be run on a machine that deals with the stock in the later processes will contain more flutes than a roll of the same diameter that is intended to be run on a machine dealing with the stock in the earlier processes, since the cotton in the former case is not in as bulky a condition.

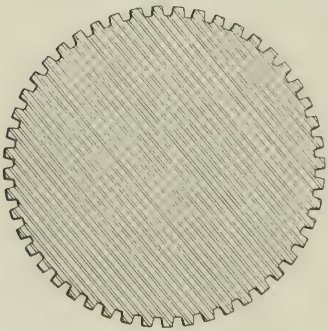


FIG. 2

Rolls are often made with the flutes unevenly spaced; that is, the distance between two flutes in one place is different

from the distance between two flutes in another part of the same roll. This is done in order to prevent the cutting of flutes in the top leather roll that would correspond with those of the bottom roll, which would be detrimental to good work. It is also necessary to have these rolls refluted at times, since the constant action of the cotton on the flutes will wear them very smooth on the edges and thus prevent their gripping the fibers. It is important not to have the roll stands for the bottom rolls too far apart, since in this case the roll, due to the weight of the top rolls and other weight placed on it, will be deflected out of a straight line, causing the roll to run untrue and resulting in poor work.

The bottom rolls are almost always case-hardened in the *necks*, or bearings, and in some cases throughout. They are thus rendered stiffer and stronger, which makes them more capable of resisting torsion, the necks wear longer, and the flutes are not so liable to become damaged by an accident or by carelessness. The preservation of the necks is also assisted by inserting brass bearings into the roll stands.

3. Method of Connecting Sections.—The bottom rolls are built in sections varying from 13 to 24 inches in length, each section being joined to the next by means of a squared end of one section fitting into a squared recess in another section. It is of the utmost importance that these ends shall fit into their sockets accurately, and if they become worn, as is sometimes the case with the older makes of rolls composed of soft metal, they should be resquared. It will easily be seen that in a frame 20 or 30 feet long having a number of these joints in each roll, a minute fraction of play at each socket will become an important item in the whole length of the frame and tends to produce what is technically called *cut yarn*. When the rolls are removed in sections, care should be taken that each section is replaced in the position from which it was taken. In order to make this convenient, the end of each section is numbered, the numbers generally running consecutively from the driving end of the machine.

TOP ROLLS

4. Construction.—Top rolls are constructed of iron and are made in short lengths, a portion of their circumference being afterwards covered with cloth and leather. That part of the roll that is used for drawing the cotton, which in common top rolls is the leather-covered portion, is known as the *boss* and is always of a larger diameter than the remainder of the roll. Top rolls may be made with one or

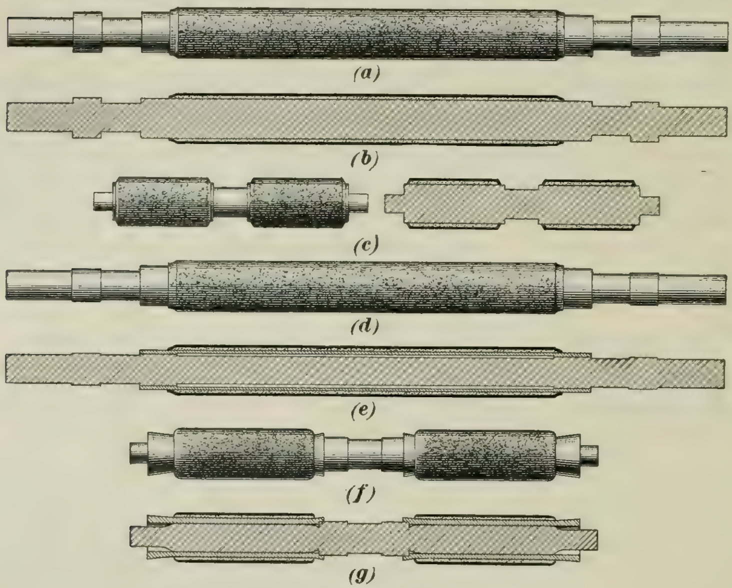


FIG. 3

two bosses, being known as *single-boss* and *double-boss*, respectively; the boss in both single- and double-boss rolls may be detachable. When the boss of a roll is detachable, the roll is known as a *loose-boss*, or *shell*, *roll;* when the boss is not detachable, the roll is known as a *solid roll*. In loose-boss rolls the part that is detachable is known as the *shell* of the roll, while the part on which the shell rests is known as the *arbor*.

Fig. 3 shows the different styles of top rolls. A solid roll having a single boss is shown at (*a*), a longitudinal section of this same roll being shown at (*b*); a solid roll with a double boss and a longitudinal section of the same roll are shown at (*c*). A loose-boss roll having only one boss and a longitudinal section of the same roll are shown at (*d*) and (*e*), while a loose-boss roll with a double boss and its longitudinal section are shown at (*f*) and (*g*).

5. Single- and Double-Boss Rolls. — In certain machines that utilize drawing rolls there is one roll to every delivery; that is, all the fibers passing one roll are gathered together into one sliver at the front; therefore, for these machines the single boss is preferred. In certain other machines there are always two or more ends coming from each roll, so that the **double-boss** construction is preferable. Sometimes one end comes from one boss; in other cases two ends come from one boss; while in still other cases three ends are found coming from each boss of a double-boss roll, making six from the roll.

The advantage of double-boss over single-boss rolls is due to the fact that there are less weights, hooks, and wires on a machine equipped with double-boss rolls and, therefore, the machine can be better and more easily cleaned. The cost of construction is also less with double-boss rolls, and the weighting is simpler. It also requires less oil, thus reducing the probability of staining the cotton. Another advantage that is claimed for double-boss rolls with the loose boss is that any slight variation in the diameter of either boss, as compared with the other, is offset to a certain extent, on account of the independent motion of each boss.

One great advantage that the **single-boss roll** has over the double-boss roll is that more even yarn is produced with the former, as each end or group of ends is treated independently of the others.

6. Solid- and Loose-Boss Rolls.—**Solid-boss rolls** are gradually passing into disuse except for the back rolls of frames, being replaced by rolls with loose bosses. With

a **loose-boss roll** only the shell revolves, consequently the neck and ends do not need oiling. When it is desired to oil the roll, the shell is removed and a few drops of oil placed on the arbor. With such a construction, especially when such thorough lubrication can be obtained, it is very easy for the shell to revolve and there is also little danger of oil getting on the cotton.

The portion of the arbor enclosed by the boss is barrel-shaped, being large at the center and tapering off toward each end. This construction reduces the friction by reducing the bearing surface of the shell on the arbor, and the oil tends to run toward the thickest portion of the arbor, thus insuring proper lubrication and preventing the leakage of oil.

Rolls are also constructed on this principle with the shell having ball bearings on the arbor.

COVERING TOP ROLLS

7. As two metal rolls revolving in contact would tend to crush the delicate cotton fibers, a leather covering is provided for the top rolls of the common type. The iron surface of the roll is first covered with a specially woven woolen cloth, which is cemented to the roll, giving a good, elastic foundation. When a thin leather covering that fits very tightly is drawn over this foundation, the roll is capable of gripping the fibers and, owing to the yielding quality of the leather and cloth, does not damage them.

In order to secure the best results, the greatest care should be exercised in covering the roll, and the best stock should be used. The production of an even thread depends more on the quality of the cloth and the leather, the manner in which it is applied, and the care of the rolls in the machine than on any other factor in the process of manufacture, with the exception of the grade of cotton used. Various substitutes for woolen cloth and lambskin or sheepskin have been tried from time to time, but none have been adopted to any great extent. Woolen cloth and lambskin have been used for over 100 years for covering rolls. In fact, the first frame built

for spinning had top rolls that were covered, the skin being used without any cloth. The uncovered roll known as the metallic roll is the only one that has displaced these materials to any great extent.

8. Roller Cloth.—The cloth that lies underneath the leather should be made of the finest and best wool. The wool should be carefully carded, so that every piece of foreign matter will be removed, and the weaving and the finishing of the cloth should also receive very close attention. It should not be possible to detect by the hand the slightest variation of thickness in any portion of the cloth. American and English roll cloths are used in covering rolls. They vary considerably in weight; the American cloth is figured on a width of 54 inches, while English cloths are figured 27 inches in width. It should be remembered, therefore, in ordering roll cloth that an American 32-ounce, for example, is the same as an English 16-ounce.

In mills covering their own rolls, the old leather should be removed and the cloth carefully examined. If it shows any evidence of disintegration, or wear, or an uneven surface, it should be condemned and removed. The old cloth may be removed by soaking it in water, after which the roll should be cleaned thoroughly. When rolls are sent out to be covered, it is considered advisable to cut the cloth with a knife in order to prevent the same cloth being used again, thus avoiding the danger of having old cloth covered with new leather.

9. Method of Putting on Cloth Covering.—In covering rolls, the cloth is cut into strips slightly narrower than the boss of the roll. A strip of this cloth is then laid flat on a table and a clean roll, the boss of which is covered with glue, is placed on the end of the strip and the cloth wound on the roll. The roll during this operation should be neither hot nor cold—simply warm. The cloth is cut with a sharp knife at the point where it begins to pass around the roll the second time, and the seam is then pressed into place.

Another method of covering rolls with cloth is to lay a number of strips of cloth of the required width in a miter box

and cut them to a gauge of the required length, thus giving 15 or 20 pieces of the exact size required to cover one roll. In this way the cloth may be put on the rolls much faster than when cutting each piece on the roll. After the cloth is put on and the seam pressed together with the fingers, the roll should be put into evening, or smoothing, rolls for the purpose of smoothing out any lumps or foreign matter that may have been in the glue, thereby producing a perfectly true and even surface.

10. Leather Covering for Rolls.—In yarn-preparation machinery it is the duty of a pair of rolls to maintain a firm grip on the fibers of cotton as they are passing between them, and yet the fibers must not be damaged in any degree. The rolls at the time are revolving in some cases at a high rate of speed, and therefore the material with which they are covered should be of such a nature that it will resist a certain amount of wear. The substance that has been found most suitable to meet these requirements is the skin of the lamb or the sheep, or the skin of the goat, which, like the skins of most animals, consists of more than one layer. The outside layer is very thin and tough, and, while horny, is very elastic.

Fig. 4 is a section of sheepskin very much enlarged; *c* represents sweat ducts and *d* the epidermis. This is the part that withstands the wear when at work. It consists of a horny layer above the Malpighian nets, or inside layer, and is commonly called the *grain*. A fibrous tissue *e* binds the true skin *f* to the epidermis *d*. This fibrous tissue is formed of multitudinous fibers bound together by a soft, milky, gelatinous substance. Hollow, loose skins result if this substance is improperly treated during manufacture.

On the character of the fibrous tissue, which is directly beneath the grain, depends the strength of the skin; the larger the size of the skin, the coarser and weaker it will be. The explanation of this is that there are a certain number of fibers in the tissue at the birth of the lamb that increase in thickness but do not increase in numbers with the growth of

the animal. The spaces between these fibers are filled in with a quantity of the gelatinous substance mentioned, much of which is dissolved in the process of manufacture. Therefore, as the strength of the skin depends on the number of fibers, and since in 1 square inch of lambskin there are more fibers than in 1 square inch of sheepskin, the younger skin will be the stronger.

Beneath the mass of muscular fibers is the layer *f* that is next to the flesh of the animal. This layer is composed of

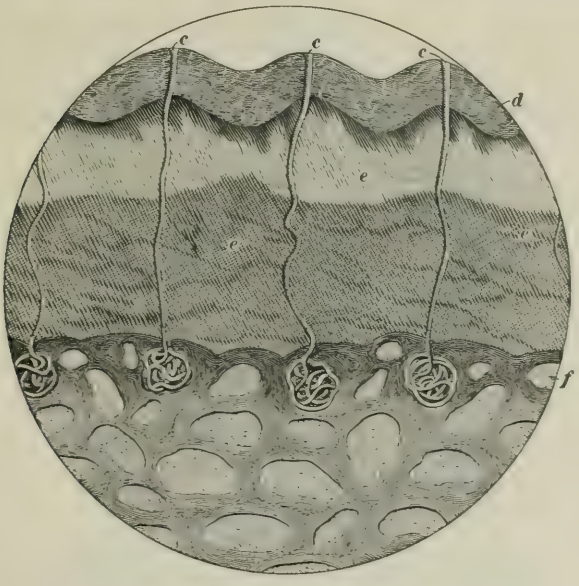


Fig. 4

cellular matter and varies in thickness in different parts of the skin. If a roll were therefore covered with a skin of natural thickness, some rolls or parts of the same roll would vary in thickness. In order to make the skin the same thickness throughout, a process known as **shaving** is employed.

As skins are usually thicker over the spine from the tail to the neck, a test can be made after the shaving process to determine whether they are the same thickness throughout by making a pile consisting of 50 or 60 skins. If the pile is

higher in the center than at any other portion, the shaving process has not been performed properly.

11. The color should also be taken into consideration when selecting a skin. English skins usually have a color known as the natural oak-bark color, which is a light brown, while others are given a reddish color by means of dye. American skins are usually of a dark-cream color. The red color is preferred by some spinners, who claim that because of the color they can more readily see when the cotton is absent from the rolls, but as the rolls get to be somewhat of the same color after being used a few days, the red does not possess an advantage in this respect for any length of time. The darker the shades, however, the more the grain defects are hidden from view.

The size and color of skins depend on the size and age of the animal from which they are obtained. Lambskin is used for the more delicate work, as it is finer than sheepskin, while sheepskin (especially that which is old, being thick and coarse) is used for the coarser work. A top roll is really a cushion that will only yield enough to prevent crushing the fibers and yet maintain a pressure against the steel roll. As the covering for rolls on coarse work must yield to a greater extent than that of rolls on fine work, it is evident that the thicker skin and the heavier cloth should be used on rolls for coarse work.

12. Selection of Skins.—The skin from which the largest number of roll coverings can be obtained is the most economical to use, and the number of coverings that can be obtained from a skin should be estimated when purchasing. A *cot* is the piece of leather intended to cover one boss of a roll, cut to a rectangular shape with two of its edges afterwards joined together so that the leather will form a tube. The skin should be purchased by the minimum measurement; that is, it should be measured at its shortest parts. The diagram shown in Fig. 5 will serve to illustrate this point. A parallelogram *a a a a*, which indicates the area of the number of leather tubes, or cots, that may be cut, is placed

on the skin and, if the skin is shorter than the distance *b b* or narrower than the distance *c c*, the skin is below the minimum measurement. The neck should not be measured, as it is not suitable for roll covering.

The shape of the skin shown in Fig. 5 is the best for roll skins. If there are any defects, such as knife cuts, or any evidence of overshaving on the flesh side, the skin is not of the first quality and can only be used on coarse work.

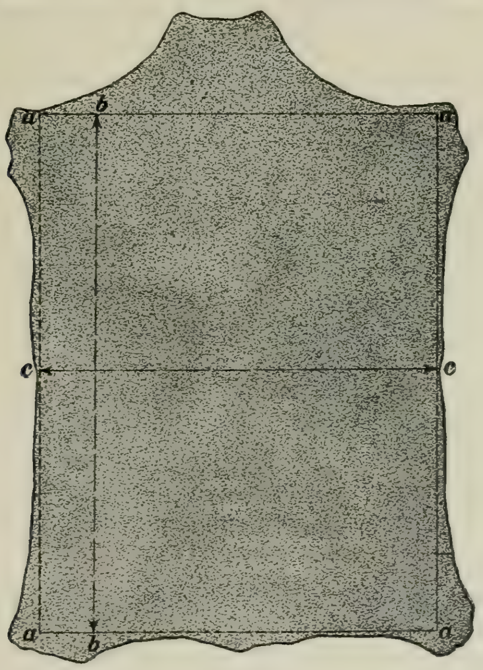


Fig. 5

Another serious defect is the presence of fine hairs, and if such are detected the skin should be condemned.

A hard-grained skin, in which the firmness is introduced by the method of finishing the skin, will not act successfully as a cushion. The grain side of the skin should feel smooth and firm, yet be pliable and capable of expansion and compression, while the flesh side should have a nap as fine as cloth. The effect of handling the whole skin should be the

same as handling a kid glove, allowing for the difference in substance. The skin when placed under tension and examined by a magnifying glass should show an unbroken surface with no cracks on it.

13. Method of Putting on Leather Covering. When placing the leather covering on rolls, the skins are cut up into strips rather wider than the boss of the roll so as to allow for burning off the ends. The strips are next cut into small pieces just sufficient to fold around the boss of the roll, and their ends are beveled so as to make a joint that will not be perceptible to the touch. Beveling machines are used for cutting the bevel, the skin being placed in the machine so that the knife enters at the flesh side. The beveled ends are next joined together with cement, great care being taken in performing this operation. The leather tube, or cot, is placed in a press for a short time in order to insure a perfect joint. Hand or power presses are now constructed in which cots may be made and pressed.

The next operation is to draw the cot over the boss of the roll—an operation somewhat similar to drawing the finger of a glove on the finger. The roll is then revolved at a high rate of speed and any part of the leather that projects over the boss is burned off by friction with a hard piece of wood. The charred portion of the skin forms a collar at the ends of each boss.

With long rolls it is difficult to make a cot of exactly the same diameter throughout and draw it on the roll with the same tension in every part. This difficulty is overcome by some roll coverers by taking a long strip of leather and winding it around the roll spirally, attaching it with cement as they wind it on. The skins in this case are cut into strips from 1 inch to 1½ inches wide.

The extra cost of covering and the extreme care that is necessary in order to keep the roll true are the disadvantages of this method. It is also claimed by some that the cushion effect of the leather is destroyed by this method of covering, as a hard piecing extends completely around the roll

throughout its entire length; while on the roll covered with a cot, there is one hard piecing straight across.

Among the precautions that should be observed is the manner in which the roll is placed in the machine. It should be placed so that it will not run against the joint, and in some cases the way the lap runs is marked by a dot of ink on the grain side of the skin. In putting cots on double-boss rolls care should be taken that the bevels run the same way and that the cots are of the same thickness.

VARNISHING

14. It is the general practice in almost all mills to varnish the rolls that perform the heaviest work; namely, the rolls of the railway head, drawing frame, comber, sliver lap, ribbon lap, and in some cases the slubber. The reason for this is that the grain of the leather wears away and becomes broken, on account of the high speed at which the rolls revolve and the heavy work that they have to do compared with rolls in other frames. It is therefore necessary that something should be used as a substitute for the natural grain of the leather, which gives the roll its drawing properties, and a varnished surface has been adopted as the most practical.

Varnished rolls should present a smooth, hard surface that has dried without cracking and that does not cause fiber or dust to adhere to it. Too much glue in the varnish gives the rolls the appearance of a highly polished surface, which has a tendency to crack when dry, while too little allows the varnish to wear away very quickly. Almost every mill has its own system of preparing varnish, while roll coverers have for sale various compositions for this purpose.

15. Recipes for Roll Varnish.—Three recipes for preparing varnish are given:

1. 9 ounces of fish glue; 2 quarts of acetic acid; 2 teaspoonfuls of oil of Origanum. This mixture should stand for about 2 days in order that the glue may be thoroughly dissolved, after which it may be thickened with fine powdered paint of any color that may be desired.

2. $1\frac{1}{2}$ pounds of fish glue; $\frac{1}{2}$ pound of gum arabic; $\frac{1}{4}$ pound of powdered alum; 2 pounds of acetic acid; 4 pounds of water. This mixture should be thoroughly dissolved over a slow fire, after which it may be thickened with paint in the same manner as in the first recipe.

3. 1 ounce of ordinary glue; $\frac{1}{4}$ ounce of fish glue; $\frac{1}{4}$ ounce of gum arabic. This mixture should be dissolved in $2\frac{1}{2}$ gills of water and allowed to simmer for 1 hour over a slow fire, after which 6 ounces of thoroughly ground paint of any color may be added to thicken it.

In mixing any varnish it should be done in a regular melting pot in order that it may not be burned. After the varnish is made it may be kept in stock for any length of time, but should be put away in a covered receptacle; it is advisable to have this cover air-tight, although it is not absolutely necessary. If when it is desired to use the varnish it is found to be too thick to spread properly on the rolls, it may be thinned by adding a little vinegar, or acetic acid; while on the other hand if it is found to be too thin, a little paint may be added to thicken it.

16. Method of Applying the Varnish.—The methods of putting the varnish on the rolls differ. One method is to apply it with a brush the same as in painting a round stick, taking care to spread the varnish evenly over the surface of the leather so that when it is dry it will have a true, smooth surface. Another method is to have a board made a little longer than the roll and about as wide as the roll is long. The upper part of the board is covered with woolen cloth, the cloth being pulled tightly and tacked at the edges. The varnish is put on the cloth with a brush and the roll moved over the surface of the cloth by placing the palm of each hand on the bushing of the roll and moving it backwards and forwards until the varnish is spread over the whole surface.

In some cases before the roll is varnished it is ground, in order to insure its being the same diameter throughout its length. This is a practice that should not be encouraged, as it shortens the life of the leather.

The rolls are generally given one coat of varnish, although sometimes where fine numbers are required they are given two coats. New, or newly covered, rolls are given two or even three coats before they are put into the frame, one coat being allowed to dry before another coat is put on. Care should be taken that the rolls are perfectly dry before they are put back into the frame, since if this is not done the cotton will stick to them, making it almost impossible to run the frame. The rolls, if not dry, will also become fluted.

METALLIC ROLLS

17. For many years inventors have endeavored to substitute something for the common, leather-covered top rolls, principally because the covering of these rolls is an item of considerable expense in the production of yarn, and also because they are troublesome in certain conditions of the atmosphere or for certain kinds of stock, especially colored or bleached stock, on account of their licking and causing bad work. The most practical of the substitutes that have been tried is to have flutes in the top steel roll corresponding to those in the bottom roll. The flutes of the rolls mesh together, but in order to prevent the teeth of one roll from reaching to the bottom of the spaces between the teeth of the other roll, the rolls are held somewhat apart by collars.

There is a wider space between the flutes of metallic rolls than there is between the flutes of the common bottom steel rolls, the spacing being the same for both top and bottom rolls of the same pair. There are, however, different spacings in different pairs of rolls and, as now applied, wider spacings are used for back than for front rolls.

18. Construction.—A mounted section of a set of metallic rolls is given in Fig. 6, while Fig. 7 represents a portion of a pair of these rolls. Fig. 8 is a cross-section of the same pair. b, b_1 are the fluted portions of the rolls and a, a_1 the collars, which prevent the rolls from coming into

too close contact. The flutes of the back rolls are always of a coarser pitch than those of the front rolls, owing to the greater bulk of cotton that comes under the action of the back

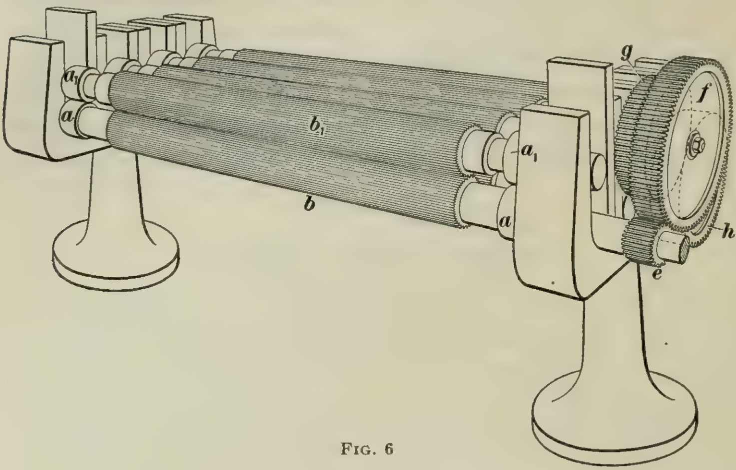


FIG. 6

rolls. The back rolls for drawing frames as now constructed have 16 flutes on their circumference for each inch of diameter. The third roll has 24 flutes, while the front and second

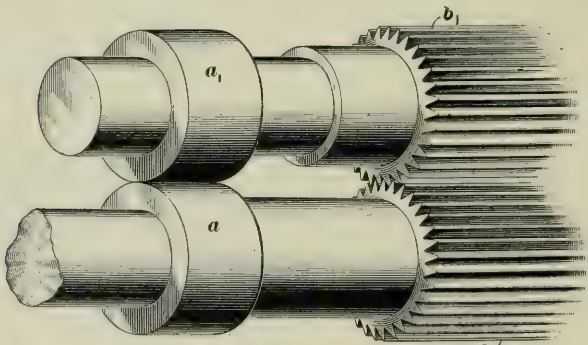


FIG. 7

have 32 flutes. They are therefore known as rolls with a 16 pitch, 24 pitch, and 32 pitch, respectively.

On a 16-pitch roll the diameter of the collars is .07 inch

less than the diameter of the fluted section, and as both rolls are the same, the amount of overlap is .07 inch. With a 24-pitch roll the collars are .06 inch less in diameter than the fluted section, and on a 32-pitch roll they are .044 inch less. Thus, the amount of overlap with 24-pitch rolls is .06 inch and with 32-pitch rolls, .044 inch. This amount of overlap is sufficient to grip the sliver as shown in Fig. 8.

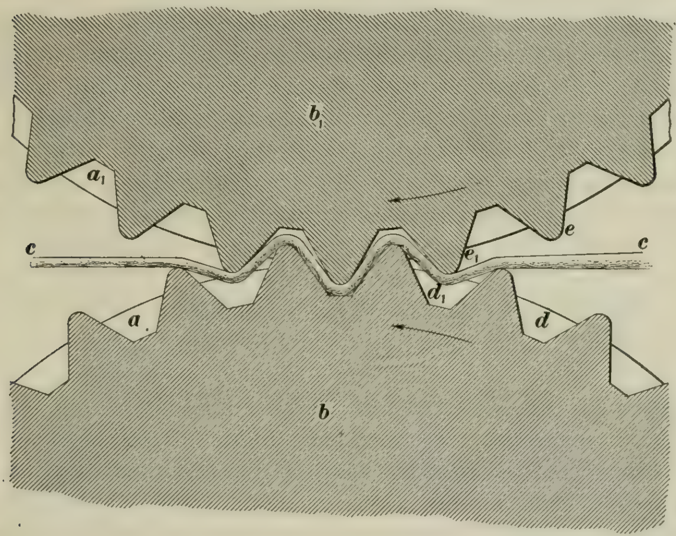


FIG. 8

It will be seen that the cotton does not follow a straight line, as it does with common rolls, but is crimped to some extent, and if the collar did not keep the rolls partly separated, the fibers would be damaged by the contact of the flutes. The amount of the overlap is so small that it merely grips the fibers enough to attain a draft and does not damage them to any appreciable extent.

19. Advantage of Metallic Rolls.—The top rolls of a metallic set are positively driven by the flutes of the lower roll meshing with the flutes of the upper roll, and consequently a more positive draft is obtained than with the

common rolls. The cost of roll covering and subsequent varnishing is saved, and the bad work that arises from imperfectly varnished rolls is entirely obviated.

It is claimed that, as metallic rolls run on collars, friction is greatly reduced; that licking, from the presence of electricity and atmospheric changes, is prevented; that consequent waste is avoided; and that the product of each frame equipped with metallic rolls is greater than a machine equipped with common rolls running under the same conditions, because of the curved path taken by the cotton. It is further stated that metallic rolls produce work that is equal in quality to that produced by common rolls and that there is no necessity of keeping extra rolls in stock. However, metallic rolls at the present time are not used to any large extent except on railway heads, drawing frames, sliver-lap machines, and slubbers.

SETTING AND WEIGHTING ROLLS

RULES GOVERNING SETTING

20. One of the most important points in relation to cotton machinery is the relative position of one pair of rolls to another, which position is governed by the length of the staple and bulk of cotton being used. The bad work that will result from the improper setting of rolls can never be remedied. In setting rolls, there is one broad principle that must always be followed: the distance between the centers of each pair of rolls must always exceed the average length of the staple of the cotton being used. If this were not so, the fiber would come under the action of the forward pair of rolls before it was released by the preceding pair, and since the speed of the rolls increases with each pair that is nearer the front of the machine, this would result in the fiber being strained and broken.

In addition to the length of staple being run, there are several other principles that should be considered in setting rolls. Rapidly revolving rolls require wider settings than

those having slow speed, since with a slow speed the rolls could be set closer together and still the fibers would be given a sufficient length of time to be drawn away from the mass of cotton without being strained. From this statement the conclusion should not be drawn that, since the front pair of rolls in any frame revolves faster than the back pair, the front rolls should be set farther from the middle rolls than the back rolls; for this is not so, as other circumstances, having to be considered, overbalance that of the speed of the rolls. Since the speed of the rolls increases with each pair that is nearer the front of the machine, the cotton as it passes through the roll is greatly diminished in weight per yard from back to front, and since it is much easier to draw the fibers past each other when there is only a comparatively small number of fibers than when there is a large number, two pair of rolls that are near the front would have a less space between them than two pair of rolls at the back. For this reason the space between each two pair of rolls in a set increases from delivery roll to feed-roll. For example, if the staple of the cotton being used on a drawing frame is 1 inch, the distance between the front and second pairs of rolls might be $1\frac{1}{4}$ inches; between the second and third, $1\frac{3}{8}$ inches; and between the third and back, $1\frac{1}{2}$ inches.

When the ends put up at the back are heavily twisted, the settings are wider on the same machine than when the ends fed are slightly twisted. This is due to the fact that it is more difficult to draw the fibers past each other in the former case than in the latter. Harsh, wiry cotton requires wider settings than smooth, silky cotton, because it does not draw so easily.

As the rolls are set according to the staple of the cotton used, it is therefore evident that the rolls intended to run on coarse counts, which is made from short-staple cotton, must be smaller in diameter than those intended to work long-staple cotton, in order that the centers of the rolls may be brought near enough together. Sometimes the middle roll is made smaller than the front and back, where three pair of rolls are used, so that a close setting may be made.

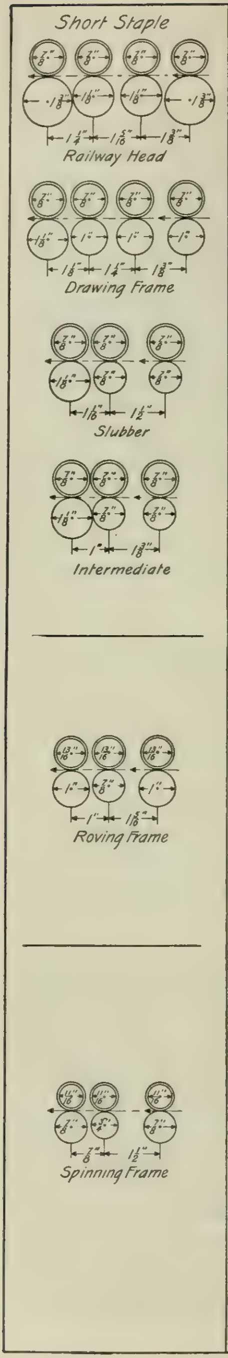


FIG. 9

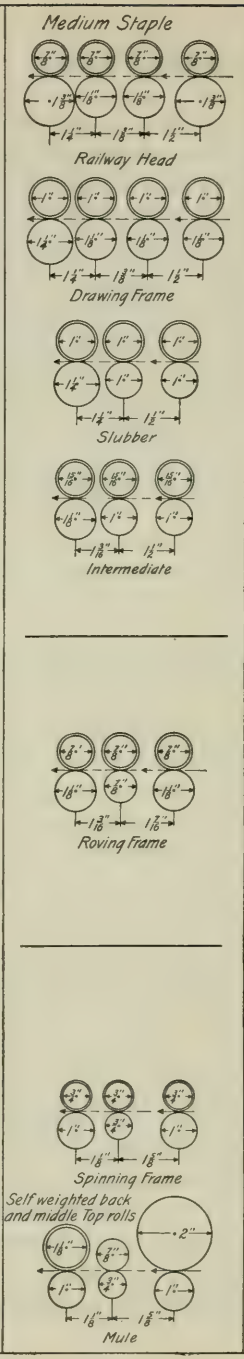


FIG. 10

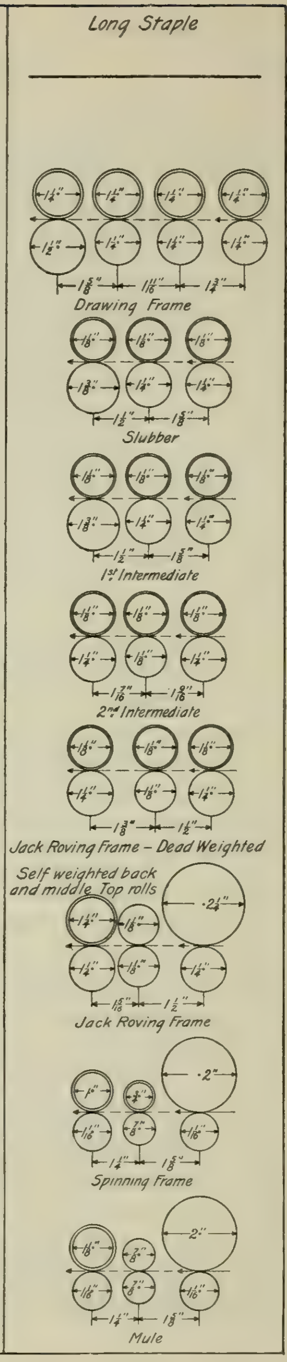


FIG. 11

The diagrams that are included in Figs. 9, 10, and 11 show the settings and diameters for different kinds of cotton, with the method of measuring distances from center to center of rolls; they will vary, however, according to conditions, as already stated.

The following settings for American cotton of about 1-inch staple are taken from actual measurements in a mill making an average of 32s:

TABLE I

	Speed of Front Roll	Weight of Sliver at Back	Distance Between Centers		
			Front and Second	Second and Third	Third and Back
First drawings	411	68 grains	$1\frac{7}{16}$ inches	$1\frac{5}{8}$ inches	$1\frac{3}{4}$ inches
Second drawings	411	68 grains	$1\frac{7}{16}$ inches	$1\frac{5}{8}$ inches	$1\frac{5}{8}$ inches
Third drawings	411	68 grains	$1\frac{3}{8}$ inches	$1\frac{5}{8}$ inches	$1\frac{5}{8}$ inches
Slubbing	162	68 grains	$1\frac{1}{4}$ inches	$1\frac{3}{4}$ inches	
Intermediate	143	.57-hank	$1\frac{3}{16}$ inches	$1\frac{5}{8}$ inches	
Roving	116	1.61-hank	$1\frac{1}{8}$ inches	$1\frac{9}{16}$ inches	
Spinning	125	5-hank	$1\frac{1}{16}$ inches	$1\frac{3}{8}$ inches	

Each case of roll setting must be judged by its requirements. Table I shows ordinary settings on the intermediates, roving, and spinning, and excessively wide settings on the drawing and slubber on account of the unusually heavy sliver and high speed; but in the mill in question, after numerous experiments were made, it was found that under the circumstances the best yarn was made with the above settings. A more ordinary setting for a 60-grain sliver, 350 revolutions per minute at the drawings, would be $1\frac{1}{4}$, $1\frac{3}{8}$, and $1\frac{1}{2}$ inches, with the same cotton.

21. Adjusting Points.—On all the attenuating machines of a cotton-yarn mill, adjustments are provided by which the distance between the rolls may be regulated. In Fig. 12, b is shown as one of the roll stands that support the rolls, this being a stand for three pair of rolls. The bearing b_1 of the front roll is cast solid with the main support b, and consequently the front-roll bearing cannot be moved. Separate

bearings, which are adjustable, are provided for the other two lines of rolls; b_2 is the bearing for the center line of rolls and is capable of sliding on b_1, while b_3, which is the bearing for

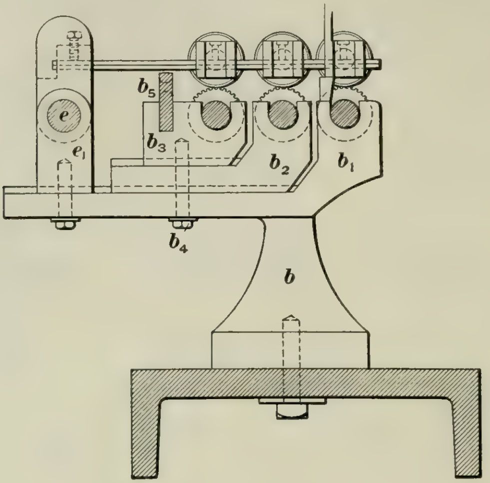


FIG. 12

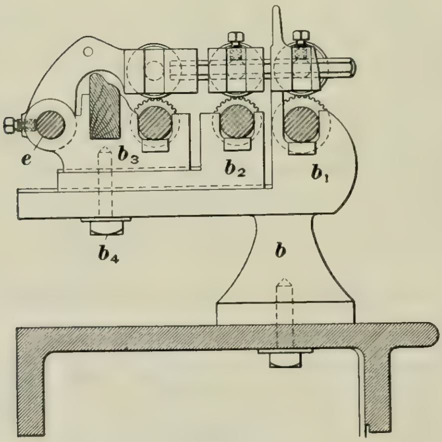


FIG. 13

the third line, can slide on b_2. Fig. 13 shows a roll stand that differs somewhat from that shown in Fig. 12, although the letters of reference will be found to apply to the same parts.

When it is desired to set the rolls, the set of top rolls that is at the end of the frame is removed, together with other sets of top rolls at frequent intervals, usually at every other stand. The screws b_4 that secure the bearings of the bottom rolls are then loosened throughout the length of the frame. The required distance between the bites of the rolls should next be determined, and from this, together with the diameter of the rolls, the distance between the bosses of each pair may be learned, after which gauges of the correct thickness are selected. For example, suppose that the distance between the centers of the front and second bottom rolls is to be 1 inch, and the front roll is 1 inch in diameter

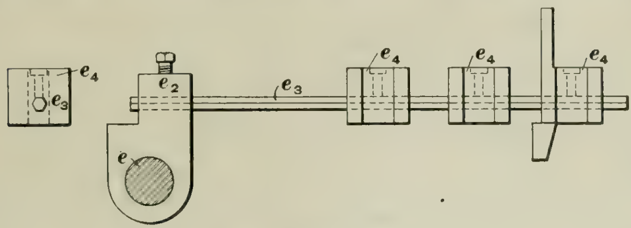


FIG. 14

and the second roll $\frac{7}{8}$ inch. Then the space occupied by the rolls themselves would be the sum of one-half of the diameter of each roll, which is $\frac{7}{16} + \frac{8}{16}$, or $\frac{15}{16}$. Since the distance from center to center is to be 1 inch, the space between the bosses of the rolls would be $1 - \frac{15}{16}$, or $\frac{1}{16}$ inch; therefore, a $\frac{1}{16}$-inch gauge would be selected in setting these rolls. These gauges are inserted between the bosses of the rolls, after which the rolls are drawn up until the gauge sets snugly, when the binding screws b_4 are tightened. This operation is repeated at every stand where top rolls have been removed. The gauges used are generally made of wood, brass, or iron and are about 2 inches long, $\frac{3}{4}$ inch wide, and of various thicknesses, in order to suit the work.

22. Cap Bars.—The top rolls have their bearing on the bottom rolls and are held in position by an arrangement of **cap bars**, one of which is shown in Fig. 14. The cap bars are constructed in such a manner that the top rolls may be

removed easily, it also being possible to readily turn the cap bars away from the bottom rolls.

The manner of supporting the cap bars is shown in Figs. 12, 13, and 14. A shaft e runs lengthwise of the frame and is supported either by brackets e_1, Fig. 12, which are fixed to the roll stand, or by the bearing of the back roll, as shown in Fig. 13. On this shaft, at various intervals, are brackets e_2, Fig. 14, that carry a long finger e_3 shaped so as to fit the hole in the casting e_2; on this finger are the nebs e_4 that keep the top rolls in position. The nebs are secured to the finger, and as the holes are made to fit the peculiar shape of the finger, they are prevented from turning.

23. Setting Top Rolls.—When setting the top rolls, it is usual to have all the rolls in position and by using the correct gauges to set these rolls so that they will come directly over the bottom rolls. In order to move the top rolls so that they will occupy the correct position, it is simply necessary to loosen the screws that hold the nebs, after which the nebs may be moved to any desired position. In some cases it is the practice to insert the gauges between the nebs, although this practice is not to be recommended, since if the nebs are not of the same thickness, the rolls will not be properly in line.

In connection with Fig. 13 it should be noted that with the stands constructed in the manner shown in this figure, the bearings for the back top roll are moved together with the bearings for the bottom back roll; consequently, when the bottom back roll is set, the top back roll will always be in its correct position. This is the more modern, and is usually considered the better, arrangement.

TOP-ROLL WEIGHTING

24. In order to maintain a grip on the fibers, the top rolls must have a constant pressure on the bottom rolls. The pressure of the top roll on the bottom roll is maintained by means of weights, light weights being applied to slow-running frames and heavier ones to frames where the rolls

run at high speeds, which cause considerable vibration and tend to jerk the top rolls. The system of weighting is classed as follows: (1) *Self-weighting;* (2) *dead-weighting*, which may be subdivided into (*a*) direct dead-weighting and (*b*) weighting with the intervention of springs; (3) *lever-weighting*, which may again be subdivided into (*a*) direct weighting and (*b*) weighting by saddles and bridles.

SELF-WEIGHTING

25. The method known as **self-weighting** consists of having the top roll heavy enough to maintain the necessary pressure on the fiber, and is used on the center and back rolls of fine roving frames, spinning frames, and mules intended for very fine spinning. The middle roll, which is usually $\frac{3}{4}$ inch in diameter, weighs from 2 to 4 ounces, while the back roll, which is from 2 to $2\frac{1}{4}$ inches in diameter, weighs from $1\frac{1}{4}$ to $2\frac{1}{4}$ pounds. This method is shown in Fig. 11, where the back and middle rolls of one of the jack-frames, the mule, and the spinning frame are self-weighted.

Since in spinning fine numbers the rolls generally have a slow speed, this amount of weighting is sufficient to give the necessary grip on the fibers. The method of self-weighting, however, cannot be applied to all classes of work, since, where the work is coarse and the top rolls require considerable weight, if they were made large enough to give this weight, they would be too bulky for use. On coarse work the rolls revolve rapidly and the vibration caused would prevent satisfactory use of self-weighting systems.

DEAD-WEIGHTING

26. The method known as **dead-weighting** is shown in Fig. 15. The rolls a, b illustrate direct dead-weighting, one weight serving for one roll; but by using a saddle d_2 and bridle d_3, as shown in Fig. 16, one weight can be used for two rolls, which reduces the number of weights on a machine.

The system of dead-weighting in which a spring intervenes between the weight hook and weight is shown on the

rolls *c*, *d*, Fig. 15. The object of adopting this construction is to have the spring tend to neutralize the effect of any slight shock that the roll may receive.

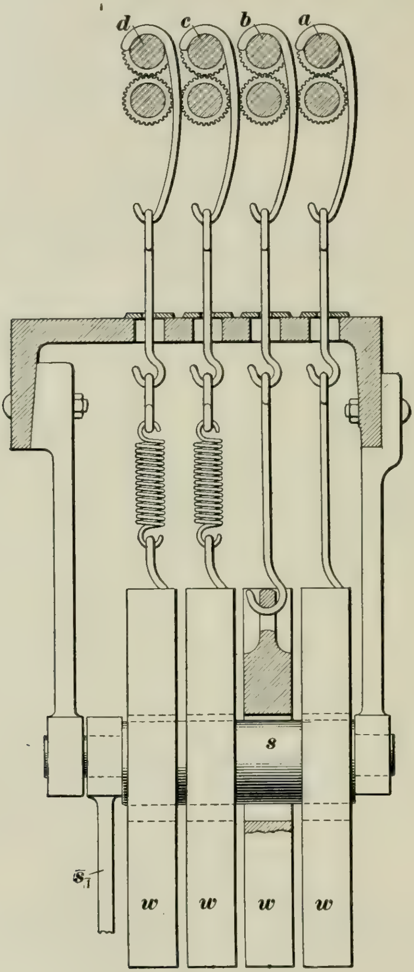


FIG. 15

If, in the case of Fig. 15, the rolls are single-boss rolls, then there will be a weight similar to *w* suspended from each end of each top roll; consequently, if the weight is,

say, 14 pounds, each top roll will exert a pressure of 28 pounds on the bottom roll. If the top rolls are double-boss

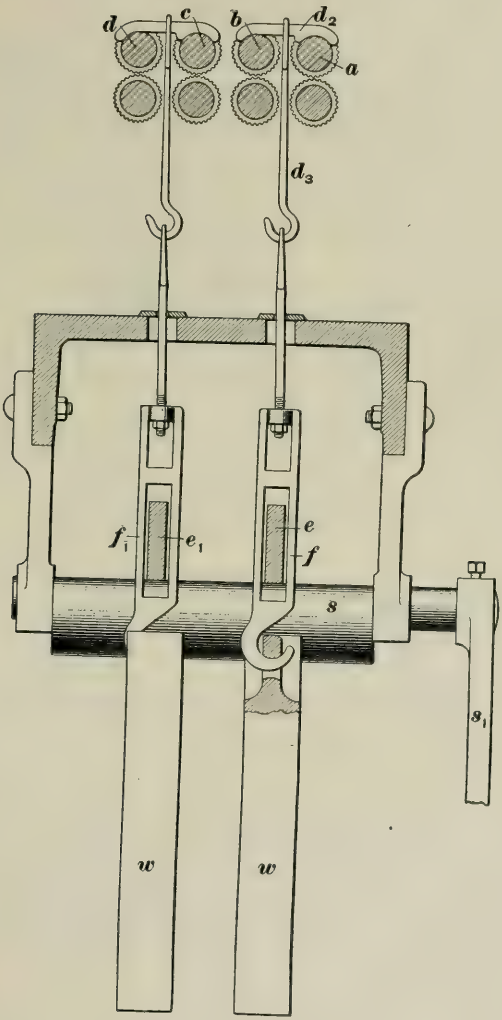


FIG. 16

rolls, there will be one weight suspended from the center of the roll, each boss having a bearing point on the bottom

roll, and if the weight *w* weighs, say, 20 pounds, each boss will exert a pressure of 10 pounds on the bottom roll.

In the case of Fig. 16, the weight *w* will be distributed somewhat differently. If the top rolls are single-boss rolls, there will be weights similar to *w* at each end of the roll, and if these weights weigh, say, 20 pounds, there will be a pressure of 10 pounds on the end of each top roll, giving a total

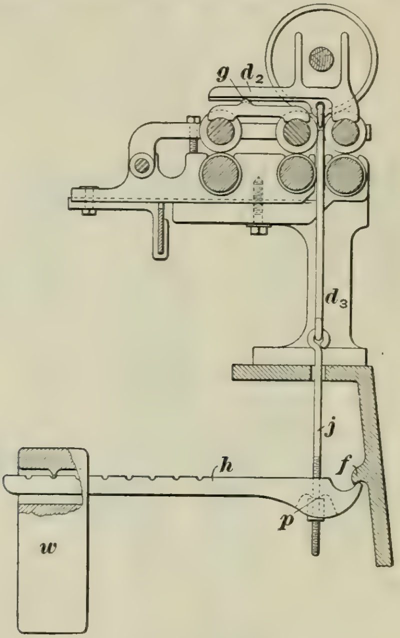


Fig. 17

pressure of 20 pounds on each roll. If the top rolls are double-boss rolls and the weight is, say, 30 pounds, then there will be a pressure at the center of each roll of 15 pounds, causing each boss of one top roll to exert a pressure of $7\frac{1}{2}$ pounds on the bottom roll.

LEVER-WEIGHTING

27. The principle of **lever-weighting** is that of exerting pressure by means of a weight acting through a lever. By this means a smaller weight may be used and

the same pressure obtained as when a larger weight is employed in the system of dead-weighting. The pressure can also be very readily varied by moving the weight on the lever.

A method of lever-weighting is shown in Fig. 17. A saddle d_2 has a bearing at its forward part on the top front roll, and also another bearing on the smaller saddle at g. The small saddle has bearings on the back and center rolls. Suspended from d_2 is a rod d_3 linked to a rod j. This rod passes through a hole in the roll beam and supports the lever h, which is fulcrumed under the roll beam at f. The lever h carries the weight w, the position of which may be varied and thus different pressures obtained on the rolls, as is desired. The method of obtaining the amount of pressure exerted at any point by lever-weighting is somewhat more complicated than in the case of dead-weighting, and in order to make this somewhat clearer, reference is made to Fig. 18, together with the following data: The weight of w is 4 pounds; the distance of $w f$ is $7\frac{1}{2}$ inches; $p f$, $\frac{3}{4}$ inch; $j k$, $\frac{5}{8}$ inch; $k l$, $1\frac{3}{8}$ inches; $l m$, $\frac{1}{2}$ inch; $m n$, $1\frac{1}{2}$ inches; $l n$, 1 inch; $j l$, 2 inches. The total pressure will equal

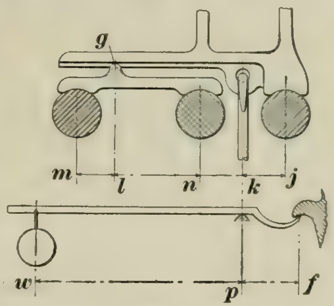


Fig. 18

$$\frac{\text{Weight} \times w f}{p f} = \frac{4 \times 7\frac{1}{2}}{\frac{3}{4}} = 40 \text{ pounds, total weight on all rolls.}$$

Part of this 40 pounds will be distributed on j and the remainder on the point g.

The pressure on j will equal

$$\frac{k l \times 40}{j l} = \frac{1\frac{3}{8} \times 40}{2} = 27\frac{1}{2} \text{ pounds}$$

The pressure at g equals $40 - 27\frac{1}{2} = 12\frac{1}{2}$ pounds, or the pressure at g will equal

$$\frac{j k \times 40}{j l} = \frac{\frac{5}{8} \times 40}{2} = 12\frac{1}{2} \text{ pounds}$$

The pressure at n will equal

$$\frac{l\,m \times 12\frac{1}{2}}{m\,n} = \frac{\frac{1}{2} \times 12\frac{1}{2}}{1\frac{1}{2}} = 4.166 \text{ pounds}$$

The pressure at m will equal $12\frac{1}{2} - 4.166 = 8.33$ pounds, or the pressure at m will equal

$$\frac{l\,n \times 12\frac{1}{2}}{m\,n} = \frac{1 \times 12\frac{1}{2}}{1\frac{1}{2}} = 8.33 \text{ pounds}$$

28. In Fig. 19, a system sometimes used for weighting the rolls of a spinning frame is shown. This method differs but slightly from that shown in Figs. 17 and 18. The

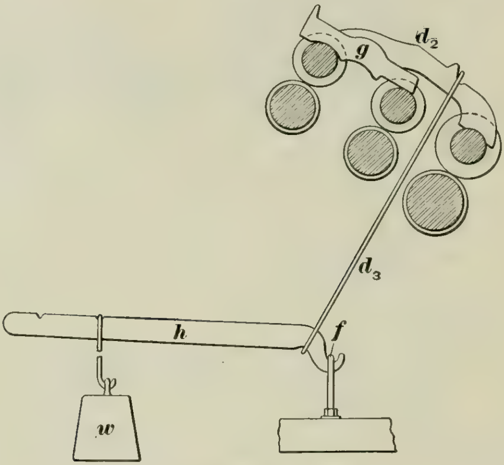


FIG. 19

weight w is supported by the lever h, which at the point f is inserted in a hook fastened to the roll beam. Connected to the lever h is a hook d_3 that is supported by the saddle d_2, which has a bearing on the front top roll and on the saddle g. The saddle g has a bearing on the back and middle top rolls.

29. Metallic rolls do not require so much weight as common rolls; usually a weight of about 14 pounds is used on each end of the four rolls of a drawing frame, although this sometimes differs and a weight of 10 pounds is used for the front, 12 for the second, 14 for the third, and 16 for the fourth. In experimental cases, metallic rolls have been run

with as low a weight as 6 pounds. Some prefer to have the heaviest weight on the front roll, claiming that as this roll revolves at the highest speed it therefore requires more weight to keep it steady. The following list of weights, which was taken from machines running medium counts, will give a general idea of the relative weights on the rolls in different machines, but it should be understood that the weights given here will serve simply as a guide, since the weights that are used are largely dependent on the ideas of the builder, the ideas of the purchaser, the construction of the machine, and the class of work to be run.

On the drawing frames using single-boss metallic rolls there was a weight of 18 pounds on each end of the front rolls, giving a total of 36 pounds pressure on the front roll. The second roll carried 16-pound weights, giving a total of 32 pounds. The third and back rolls carried 14-pound weights, giving a pressure of 28 pounds on each roll. All of these were dead-weighted.

On the drawing frames using single-boss common rolls the front rolls carried 22-pound weights at each end, the second rolls 20-pound weights, the third rolls 18-pound weights, and the back rolls 16-pound weights, giving a total weight of 44, 40, 36, and 32 pounds on the front, second, third, and back rolls, respectively.

On the slubbers using double-boss common rolls the front rolls were dead-weighted and carried a weight of 12 pounds, thus giving a pressure of 6 pounds on each boss. The middle and back rolls supported a saddle from the center of which was suspended a 12-pound weight, giving a pressure of 3 pounds on each boss of both middle and back rolls.

On the first intermediates using double-boss common rolls the front rolls were dead-weighted and carried a weight of 16 pounds, giving a pressure of 8 pounds on each boss of the roll. The middle and back rolls carried a saddle from which was suspended an 18-pound weight, thus giving a pressure of $4\frac{1}{2}$ pounds on each boss of both rolls.

The second intermediates using double-boss common rolls were dead-weighted throughout and carried weights of 18,

14, and 12 pounds on the front, middle, and back rolls, respectively, thus giving a pressure of 9 pounds on each boss of the front rolls, 7 pounds on each boss of the middle rolls, and 6 pounds on each boss of the back rolls.

On the roving frames the front rolls were common double-boss rolls, being dead-weighted, and carrying a weight of 8 pounds, thus giving a pressure of 4 pounds on each boss. The middle and back rolls were self-weighted.

WEIGHT-RELIEVING MOTIONS

30. It is necessary to use every precaution to keep a leather-covered roll as perfectly round and smooth as possible, in order to insure good work; and, for this reason, **weight-relieving motions** are applied so that there will not be any pressure on the rolls when they are to stand idle for any considerable length of time. If the pressure were maintained on the rolls during the time that they were stopped, a depression would be formed at the point where the steel roll was in contact with the leather of the top roll, because of the yielding properties of the leather, and when the machine was again started there would be a slightly eccentric running of the roll, which would produce irregularity in the work.

In some cases where there is not a weight-relieving motion, it is necessary to remove the hooks from each weight by hand. An arrangement that makes this operation easier and more simple is shown in Fig. 15. The weights w are suspended from the rolls, as shown, each weight having a hole in it through which an eccentric s passes. By turning the handle s_1 until that part of the eccentric which is farthest from the center of the shaft that supports it is at the top, the weights will rest on the eccentric, and thus the pressure on the rolls is relieved. With this method an eccentric must be provided for each set of weights.

An arrangement by which two eccentrics serve for a number of sets of weights is shown in Fig. 16, and consists of bars e, e_1 that run lengthwise of the machine and pass

through holes in the hooks f, f_1 supporting the weights w. These bars have a bearing at each end on an eccentric s and thus, by turning the eccentric by means of the handle s_1, the bars, and consequently all of the weights supported by the hooks through which the bars pass, are raised.

CLEARERS AND TRAVERSE MOTIONS

CLEARERS

31. In order to prevent the accumulation of dirt and fibers on the rolls, what are known as **clearers** are utilized. The construction of a clearer used on railway heads, drawing

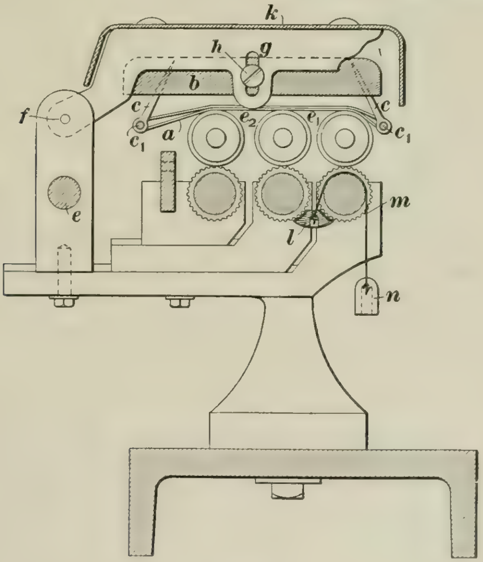


Fig. 20

frames, and fly frames is shown in Fig. 20. It consists of a piece of flannel a supported from a piece of wood b by means of rods c_1 and spikes c; b is held in position by means of screws, similar to h, which pass through a slot in a

bracket *g* attached to the roll cover *k*. By this means the wood *b* may have a vertical movement. As the flannel is pressed against the rolls by the weight of the wood, the rolls are effectively cleaned. If clearers of this type are not cleaned as often as necessary, the clearer waste will gather at the points e_1, e_2 and eventually drop into the cotton that is passing through, causing bad work at the next process.

When cleaning by hand, it is necessary to lift the cover, which is hinged at *f*, and remove the waste; to obviate this operation, self-cleaning clearers are sometimes attached. There are several styles of self-cleaning clearers; one that is being used to a very large extent consists of an endless apron of very heavy cloth that passes around two rolls, one of these rolls being situated above the back roll of the frame, while the other is situated over the front roll. The back roll of this clearer motion is driven by gearing and has a very rough surface, thus causing the cloth to revolve, while the front roll is driven by the friction of the cloth passing round it. These rolls are so placed that the cloth will press on the top rolls of the frame, thus cleaning them while the cloth itself is cleaned mechanically by a comb.

Another type of clearer is shown beneath the rolls in Fig. 20. This type may be applied underneath at the spaces between any two lines of rolls, as it is on drawing frames. On fly frames, however, it is usually put between the first and second rolls only. It consists of a piece of wood *l* as long as the box of each frame. Two faces of the clearer are curved in such a manner that they correspond with the curvature of the rolls. This clearer is covered with flannel and is held in position by two pieces of lacing, one at each end, similar to *m*. These lacings pass over the front roll of the two with which the clearer is in contact, and have weights *n* at their ends. By this means the clearer maintains a pressure on the rolls and consequently cleans them.

Another style of clearer used underneath the rolls has a wooden roll covered with coarse woolen cloth, and is held against the bottom roll by springs. This clearer is revolved

by frictional contact with the roll, and thus, whenever an end breaks, the clearer winds the cotton on itself and prevents its getting on the steel roll. This type of clearer is applied underneath the front roll.

TRAVERSE MOTIONS

32. Traverse motions in one form or another are used in connection with leather-covered drawing rolls, and have for their objects economy in roll leather and better quality of product. If the strand of cotton were permitted to pass between the leather roll and steel roll at one point continually, a groove would form around the rolls, and consequently they would soon lose their grip on the fibers. To prevent this, a motion is applied whereby the sliver, or roving, is given a traversing motion along the boss of the roll. In its simplest form the motion usually consists of a traverse bar t, Fig. 21,

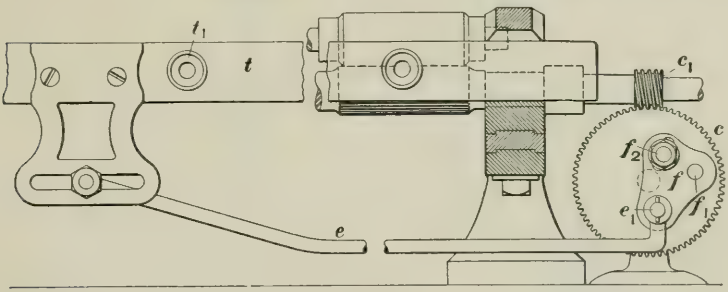
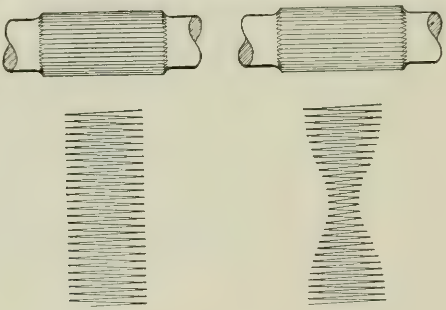


FIG. 21

that carries guides or is drilled with small holes t_1 through which the strand of cotton is passed before entering the back rolls. Attached to the traverse bar is a connecting-rod e that is connected to the crank-stud e_1. The crank-stud is connected to a casting f, which is connected to the worm-gear c by the stud f_1 and nut f_2, thus causing e_1 to be eccentric with reference to c. The worm-gear is on a short shaft and is driven by the worm c_1 on the back roll. As the back roll revolves it gives a traversing motion to the traverse bar t by means of the worm-drive and crank-arrangement.

Most traverse motions are supplied with some means of lengthening or shortening the length of the traverse. With the construction shown in Fig. 21 it is possible, by loosening the nut f_2 and swinging the casting f on the stud f_1, to bring e_1 nearer to or farther away from the center of the gear c, thus decreasing or increasing, respectively, the length of the traverse.

In some cases the traverse bar has attached to it a lever carrying a stud that is kept in contact with a heart-shaped cam by means of a spring. The cam receives motion in the same manner as the crank described, and as it revolves it forces the lever in one direction during a part of its revolution, while the spring serves to draw the lever in the opposite



(a) (b)

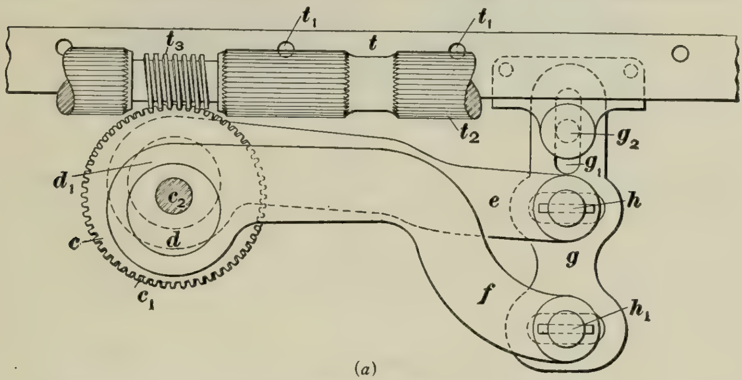
FIG. 22

direction during the remainder of the cam's revolution. The crank-arrangement is more positive than the cam and spring, but at the points of change, or where the crank-stud e_1 is at its dead centers, the motion of the traverse guide is slower than at any other part of the traverse, thus causing the strand of cotton to produce a greater amount of wear at these places. The extent of the traverse given with a cam- or crank-motion is shown in Fig. 22 (*a*).

The main principle of construction that has been sought in traverse motions is to have a variable traverse; that is, to have different lengths of sweep so that the traverse will not be continually changing at the same point on the circumference of the roll. An arrangement that gives a variable

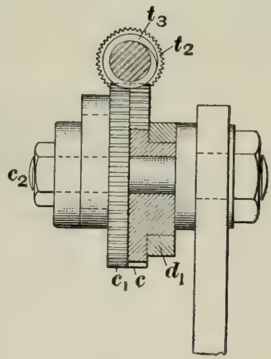
traverse similar to that shown in Fig. 22 (*b*) is shown in Fig. 23, in which (*a*) is a front view and (*b*) an end view, partly in section.

The back roll t_2 carries a worm t_3 driving two worm-gears c, c_1 that vary slightly in the number of teeth. Forming a part of the worm-gear c_1 is an eccentric d_1, while the eccentric



(*a*)

d is a part of the worm-gear c. The worm-gears c, c_1 are mounted on a stud c_2 that is supported by a bracket attached to the roll beam. Connected to the eccentric d is a lever f that is attached at its other end to a stud h_1 connected to the lower end of the bracket g. The eccentric d_1 also carries a lever e, which is connected to a stud h that is also carried by the bracket g. The bracket g is connected by means of the stud g_2 to the traverse bar t. As the worm-gears c, c_1 have different numbers of teeth and are driven by the same worm, the two eccentrics that form part of these two worm-gears will have their relative positions changed; thus, at one time the eccentrics may coincide, in which case the levers e, f will be moving the bracket g in the same direction and the traverse rod t will be receiving its shortest traverse. At another time the highest parts of



(*b*)

FIG. 23

the eccentrics d, d_1 will be brought diametrically opposite each other, in which case the lever e will be moving in one direction as far as possible, while f will be moving in the other, resulting in the traverse guide receiving its maximum traverse.

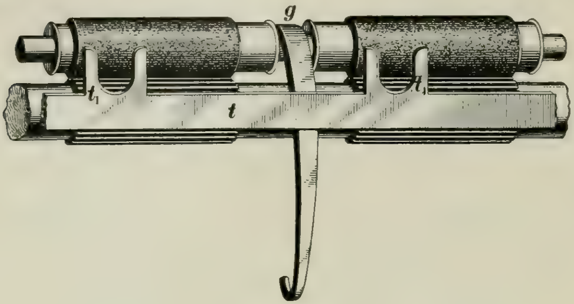


FIG. 24

The slot g_1 in the bracket g allows this bracket to be raised or lowered, thus shortening or lengthening the extreme length of the traverse, as may be desired. When the traverse guides t_1 are at the center of the boss of the rolls,

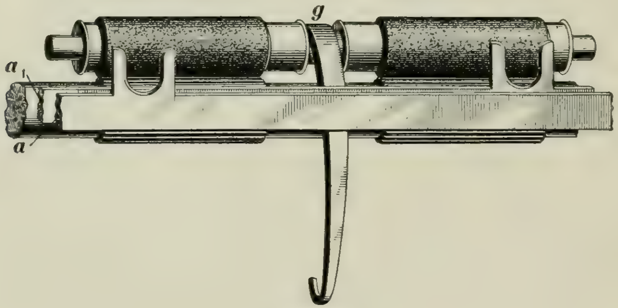


FIG. 25

the bracket g should be exactly perpendicular, and in order to accomplish the settings of the different parts, slots are provided in the bracket g at the points where the studs h, h_1 are situated, thus allowing the bracket to be placed in its correct position.

33. Double-Bar Traverse Motion.—With the traverse motions just described, it will be observed that as the cotton is passing through the guides t_1, Fig. 24, the strand nearest the neck *g*, or where the weight is applied, is under a greater pressure than the strand under the opposite boss, owing to the distance from the weight. It will be seen then that there is only one point in the traverse where the weight is equally divided between the two strands; viz., the center.

To overcome this, a motion known as the **double-bar traverse motion,** Fig. 25, has been introduced. With this motion the strands under each boss are operated by separate bars a, a_1, which move all the strands of cotton toward the necks of the rolls at the same time, thus maintaining an equal distance between all the strands and the necks of the rolls and causing the weight to be equally divided at every point of the traverse.

SCOURING ROLLS

34. The cleanliness of the fluted rolls, as well as the leather-covered rolls, is an important question, since if the dirt and other foreign matter that collects in the flutes and bearings of the rolls is not removed, considerable waste and consequent loss of production and bad work will result from the cotton adhering to and winding around the rolls instead of being delivered at the front of the machine. The cotton collecting in the bearings of the rolls will also cause the rolls to bind, and thus wear out the bearings and cause considerable strain on the gearing that drives the rolls.

The rolls should be removed periodically from the different machines in order to properly clean the bearings, necks, and fluted parts, which operation is known as **scouring.** The time for scouring depends largely on the amount of work and the kind and speed of the machine, as well as on other circumstances. The rolls in machines used for carded work should be scoured oftener than those used for combed work, and those for coarse work oftener than those for fine work. The rolls of the drawing frame should be scoured about once a month, while those of the

roving frame require scouring only about every 6 months. The times of cleaning the rolls of the frames intervening between the drawing frame and roving frame should be in proportion to the amount and quality of the work that they are producing.

When the bottom rolls are removed for scouring great care should be taken, especially when the rolls are very long, that they do not become bent or strained, since if they are replaced in the machine in this condition they are liable to bind in the stands and produce cut work. In removing the rolls two or three persons are usually employed in lifting them from their bearings and placing them on stands, horses, or brackets suitable for the purpose.

After the rolls have been removed they should be rubbed with a piece of card fillet in order to remove any dirt, hard oil, or other substances that may collect in the flutes. After cleaning the roll in this manner it should be covered with a paste made of oil and whiting and thoroughly scoured by rubbing with another piece of card fillet, care being taken not to rub around the circumference of the roll but lengthwise, so that the wires of the card fillet will follow the grooves of the flutes and clean them.

After this the roll should be wiped with a piece of dry waste, covered with dry whiting, in order to thoroughly dry the flutes before the rolls are replaced. In some cases dry whiting is used in place of the paste. Care should be taken not to allow any of the whiting to collect in the flutes or bearings of the roll.

After the rolls have been scoured they should be examined in order to ascertain if there are any rough places; and if such are found they should be smoothed by using a piece of pumice stone, a piece of very fine emery cloth, or a fine fluted file. In most cases the pumice stone or emery cloth will be found sufficient, and the file should not be used unless absolutely necessary.

The stands or bearings of the machine should be thoroughly cleaned with a piece of dry waste and examined to ascertain if there are any bearings that are badly worn; if

there are, they should be replaced, care being taken that the new ones do not stand higher than the others. If any loose joints are found in the roll, the portion containing the same should be removed from the remainder and taken to the machine shop to be repaired. The same care should be used in replacing the rolls that was taken in removing them.

It is advisable after the rolls have been replaced to place a small portion of grease on the necks of all the rolls before the top ones are replaced. This insures a perfect lubrication of the bearings and lasts longer than oil; it also avoids the necessity of frequent oiling, although the rolls should be oiled at least once a week.

If leather-covered top rolls are used in a machine these should be thoroughly cleaned and revarnished and the bearings oiled before being replaced, while if metallic top rolls are used they should be cleaned in a manner similar to the bottom rolls.

RAILWAY HEADS AND DRAWING FRAMES

RAILWAY HEADS

INTRODUCTION

1. A machine in use in some of the older cotton mills of the country but fast passing into disuse is that known as the **railway head.** At one time it was the custom to arrange stationary flat cards in sections of from six to twelve, and instead of having a coiler at each card, as is now customary with the revolving flat card, a long trough was placed in front of each section of cards, so that the sliver was deposited on an apron in the trough, or *railway*, and carried to the head end of the section. At this head end, or delivery end, was placed a machine, called a railway head, from its position at the head of the railway, into which the slivers from the cards were drawn and combined into one sliver. This must not be confused with a somewhat similar arrangement in mills making double-carded yarns, by which the slivers from one section of cards are combined into a lap or portion of a lap to be recarded. Both of these arrangements are now passing out of use, the most popular and most satisfactory method of preparing carded yarns being to use the revolving flat card, at which the sliver is deposited in a can by means of a coiler; the full can is then carried directly to the back of the first drawing frame. In some cases, the sliver is taken from the card to the back of

a railway head of modern construction, which takes the place of the first drawing frame.

The older style of railway heads, which are combined with a section of cards, will be only briefly described; but a full description will be given of those that are used entirely separate from the cards. In the older type, when the cotton sliver leaves each card it is delivered into a trough on to an endless apron, about 12 inches wide, that consists of canvas covered with a layer of rubber. At intervals along the trough are sets of wooden rolls, the upper ones resting on the cotton and condensing the slivers, while the lower ones support the apron; both the top and bottom rolls are driven by friction. After passing the point where the last card delivers its sliver into the trough, all the slivers pass between two solid steel rolls, which condense the slivers into a still more compact mass; these rolls are positively driven and the lower roll drives the apron. The assembled slivers, after leaving the apron, form a compressed sheet of cotton, thicker in the center than at the edges, and pass to the back roll of the railway head. The slivers are delivered into the trough in such a manner that more will lie in the center of the apron than at the edges. Thus, the whole of the cotton is more liable to remain on the apron than if it were as thickly distributed at the edges as in the center.

It is obvious that coilers and cans are not needed at each card, the product from a whole section of six, eight, ten, or twelve cards being delivered to one railway head, which deposits it in a can about 20 inches in diameter. In principle this type of railway head differs in no way from those used at the present time, and in construction resembles that described in Art. **10** and illustrated in Figs. 7, 8, and 9.

2. Objects.—The objects of the railway head are as follows: (1) To even the sliver as far as possible; (2) to parallelize the fibers of the sliver. The methods by which these objects are attained are: (1) doubling, or combining several slivers into one; (2) using an evener attachment;

(3) drafting, which causes the fibers to lie more nearly parallel.

It will be noticed that no mention is made of any cleaning action; in fact, in the ordinary layout of cotton mills the cleaning of the fiber from impurities ends with the card. This is not always true, however, because in mills making very fine or high-grade yarn a cleaning process, known as *combing*, is introduced, but this is seldom used in mills making any other class of yarn. It may be accepted as generally true that any machine subsequent to carding is not intended as a cleaning machine.

PRINCIPAL PARTS OF THE RAILWAY HEAD

3. Front and back views of a railway head that takes the sliver from the cans filled at the card are shown in Figs. 1 and 2, respectively, while Fig. 3 shows a plan view of the same machine with covers and certain parts removed. The usual number of cans placed at the back of this machine is eight, although it is also constructed for other numbers. Referring to Figs. 1, 2, and 3, the slivers from the cans at the back of the machine pass through the guides a, over the spoons b, there being one spoon to each sliver, and then to the back rolls c. The slivers are then subjected to the drafting action of four sets of rolls, and passing from the front rolls c_1 are combined into one sliver at the trumpet d, from which they pass to the calender rolls c_2, c_3, through a coiler, and into a can, the coiler and can arrangement being very similar to that found at the card.

Railway heads are built in two styles, single and double, Fig. 1 illustrating what is known as a single railway head. Double railway heads are constructed much the same as single railway heads, the principal difference being that in the former case two machines are combined into a single machine having two heads and, consequently, two deliveries. By this means a slight saving in floor space is effected, by slightly reducing the length as compared with two single heads, and also by reducing the number of passages among the machines; there is also a slight economy of power.

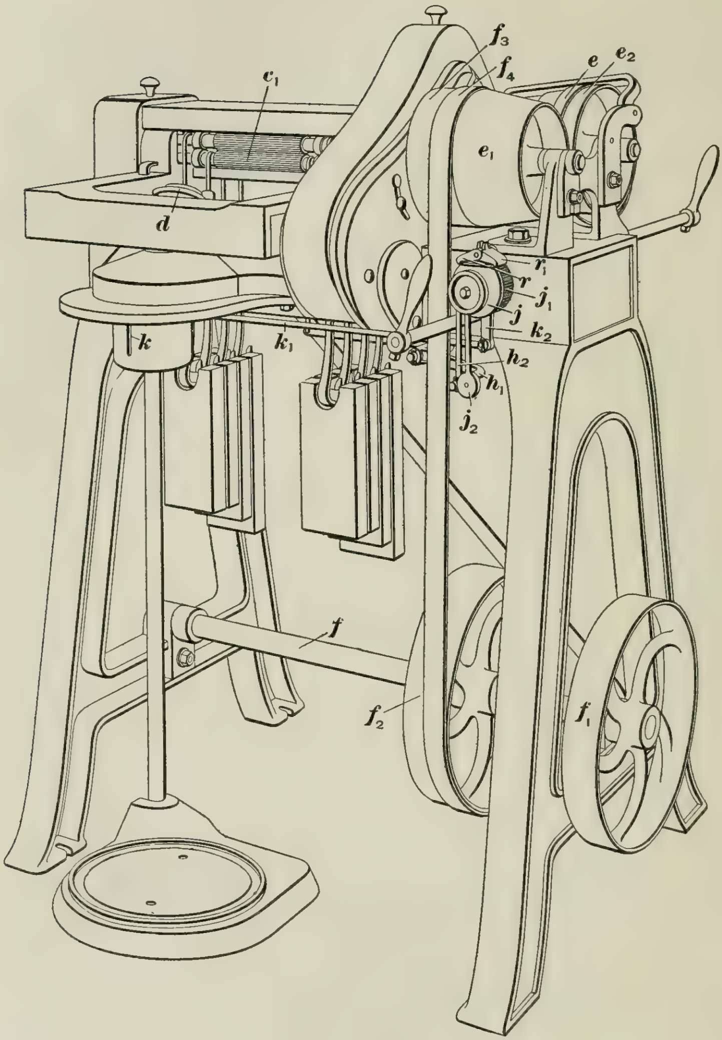


FIG. 1

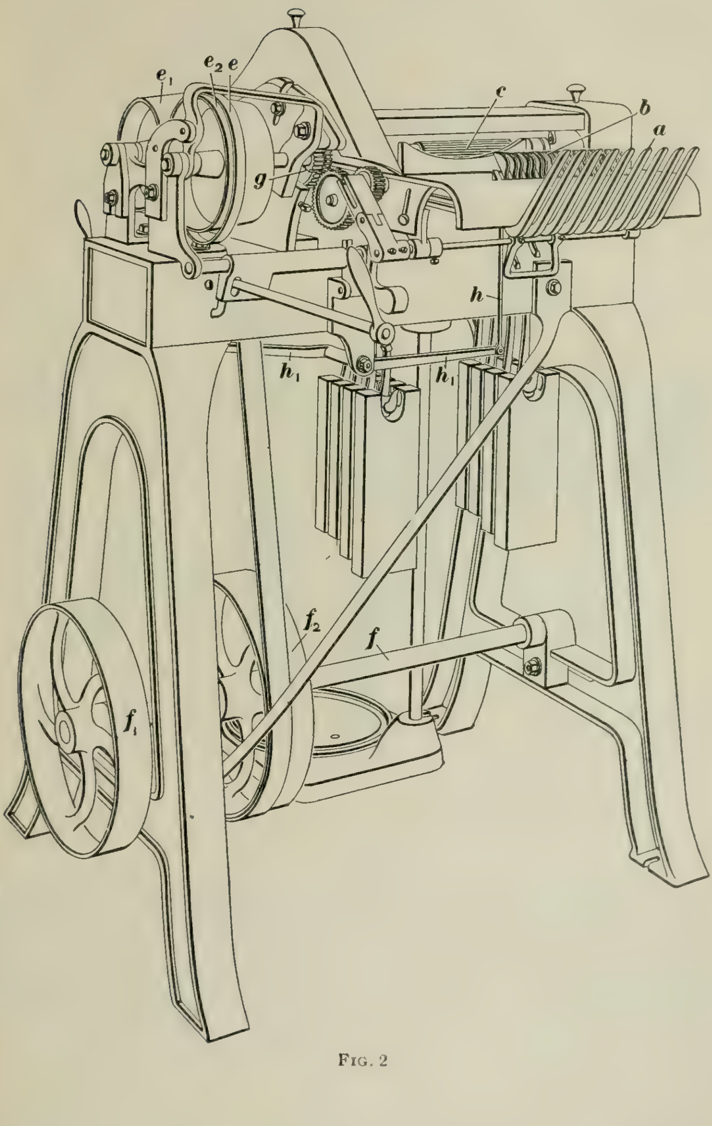


FIG. 2

Stop-motions are provided on railway heads to stop the machine when a sliver breaks or runs out at the back, when the sliver breaks at the front, and when the can at the front becomes too full. Since all these motions are similar to

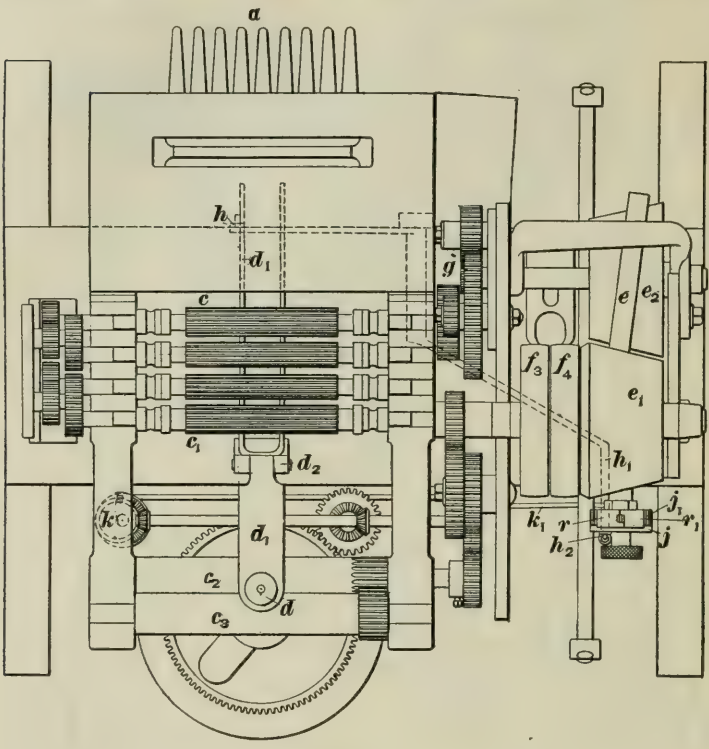


FIG. 3

those serving the same purpose on the drawing frame, which will be fully described later, a description of them is not given here. One motion, however, that is found on the railway head but is not applied to drawing frames, namely, the *evener motion*, is given a complete description.

EVENER MOTION

4. The object of the **evener motion** of a railway head is to so regulate the draft of the machine by means of cones that, in case the total weight of the slivers fed in a given time varies, the weight per yard of the sliver delivered remains the same. These cones may be placed either under the machine or at the side, the latter method being adopted in the machine illustrated in Figs. 1, 2, and 3, where the cones are shown at e_1, e_2. Referring to Fig. 1, the pulley f_1 on the shaft f is driven from the main shaft or countershaft of the room. On the shaft f is another pulley f_2, which drives the tight and loose pulleys f_3, f_4. Both the tight pulley and the cone e_1 are fast on the end of the front roll c_1, so that the speed of these parts is the same and constant. The cone e_1, by means of a friction belt e, drives the cone e_2. This friction belt simply forms a ring that passes loosely around the cone e_2 and is capable of being shifted from one position to another by means of a belt guide. These parts are more clearly shown in Fig. 3. Fast to the shaft with the cone e_2 is the gear g, Figs. 2 and 3, that drives the back rolls c by means of suitable gearing. The back roll drives the third roll; consequently, the draft between these two rolls is always constant, provided that the gears on the ends of these rolls are not changed. This is also true of the front and second rolls, since the second roll is driven from the front. Thus the break draft in this case is between the second and third rolls, so that if the back and third rolls are speeded faster or slower, the break draft and, consequently, the total draft of the machine will be changed. Thus it will be seen that the position of the friction belt between the two cones regulates the draft of the machine. For example, if the friction belt is between the large end of the driving cone e_1 and the small end of the driven cone e_2, then the cone e_2 will be driven at its maximum speed, which in turn will drive the back rolls at their highest speed, thus increasing the feed and diminishing the draft of the machine, since the speed of the front rolls remains the same. On the other hand, if the friction belt is

shifted to the small end of the driving cone and the large end of the driven cone, then the cone e_2 will be driven at its lowest speed, which in turn will drive the back roll at its lowest speed, decreasing the amount of stock fed in and increasing the draft. This is the method adopted on railway heads to regulate the weight of the sliver delivered; that is, if the weight fed is too heavy, the draft is increased, whereas if the weight fed is too light, the draft is diminished.

5. In all railway heads, the principle adopted to control the movement of the belt on the cones consists of passing the

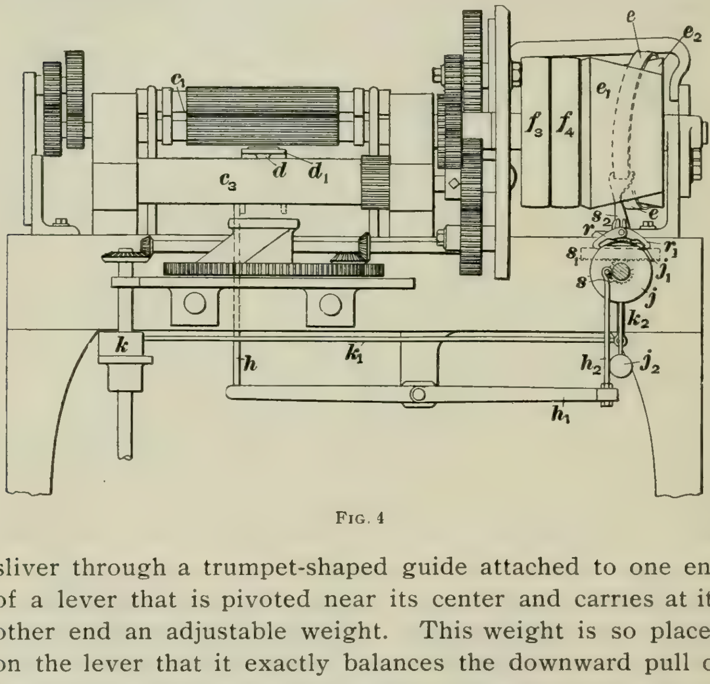


Fig. 4

sliver through a trumpet-shaped guide attached to one end of a lever that is pivoted near its center and carries at its other end an adjustable weight. This weight is so placed on the lever that it exactly balances the downward pull of the sliver when the correct weight is passing through the trumpet; consequently, if the sliver is too light, the trumpet rises, while, on the other hand, if the sliver is too heavy, the trumpet is depressed, the belt in either case being moved to the correct position on the cones to restore the sliver to its correct weight.

In describing the method of regulating the position of the friction belt between the cones, reference is made to Fig. 4, which shows a front view, and Fig. 5, which shows a side view, partly in section, of the parts of this motion; as most of these parts are also shown in Fig. 3 and are lettered the same in each figure, reference should be made to all three figures. The trumpet d is situated on a long lever d_1 pivoted at d_2 and connected at its rear end to a rod h, which in turn is connected to a rod h_1 running diagonally across the machine

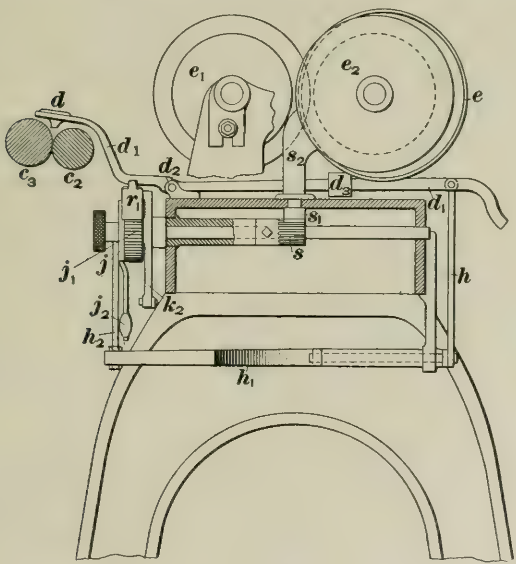


FIG. 5

from back to front, as shown by the dotted lines in Fig. 3. Connected to the rod h_1 at the front of the machine is a vertical rod h_2, which is connected to a shield j that nearly covers a gear j_1. The top part of this shield is cut away in order to expose the teeth of the gear j_1 for a short distance. The weight j_2 simply serves to steady the shield. Worked by an eccentric k is a rod k_1 that extends across the front of the machine and is connected at its other end to an upright rod k_2, which imparts a horizontal oscillating motion to the pawls r, r_1.

On the shaft with the gear j_1 is a gear s that meshes with the teeth of a rack s_1, which carries the belt guide s_2 that governs the position of the friction belt e.

The action of this mechanism is as follows. The weight d_3 is so placed on the lever d_1 that when the correct weight of cotton is passing through the trumpet d, the pawls r, r_1 rest on the outside of the shield j and the friction belt is at the center of the cones. If, however, the cotton passing through the trumpet is too heavy, the trumpet is pressed down, which action will raise the back end of the lever d_1, causing the rod h to be lifted. The rod h in being lifted brings with it the back end of the rod h_1, thus causing its forward end to be lowered, which in turn lowers the rod h_2, turns the shield to the left, and exposes the gear j_1 to the action of the pawl r. As the gear j_1 is turned, the gear s is turned, moving the rack and the belt guide in such a direction as to shift the friction belt toward the large end of the driven cone, thus causing less cotton to be fed in and decreasing the weight of the sliver delivered at the front. This allows the weight to bring the trumpet and the parts connected with it to their normal positions, causing the shield to again prevent the pawls from acting on the gear j_1. In case the sliver passing through the trumpet at the front of the machine is too light, the action of the different parts will, of course, be the exact reverse of that described. It is possible to so alter the throw of the eccentric k that the action of the pawls will give a change as small as $\frac{1}{2}$ grain to the yard for each motion of the pawls, or as great as $1\frac{1}{2}$ grains to the yard.

6. The chief criticism that can be made on a railway head is that it does not act on the stock passing through it until at least a part of the faulty stock it is supposed to correct has passed beyond the action of the evener motion. For example, the evener motion illustrated here is actuated by the trumpet, which is at the front of the machine, while it regulates heavy or light work by changing the speed of the back rolls; consequently, any sliver that is heavy or light enough to cause the trumpet to change its position will have already

passed into the can before the draft of the machine is changed, and the weight of that part of the sliver at least will not be remedied. On some railway heads, the draft of the machine is changed by the evener motion altering the speed of the front rolls, but the same criticism still holds good.

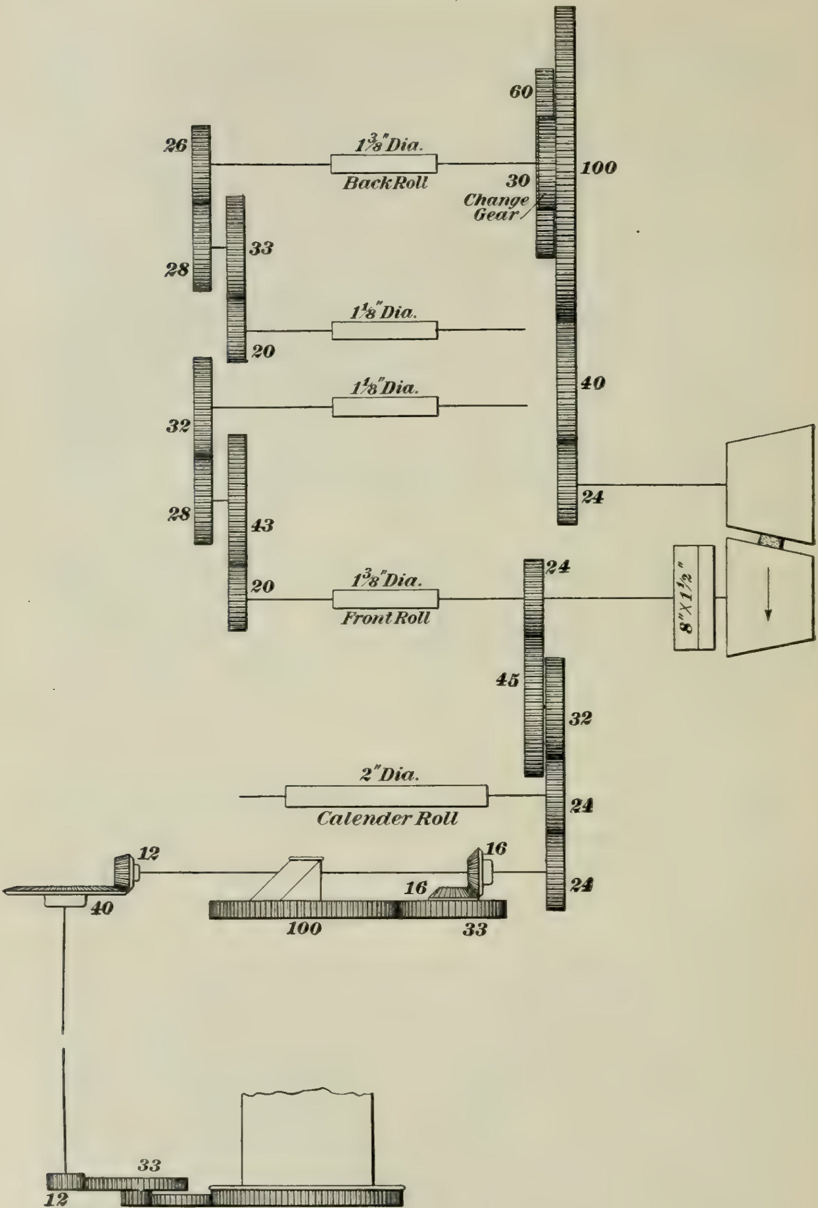
The evener motion of a railway head is the most difficult part of the machine to keep in good running condition, and care should be taken that all of its parts are always clean and that all the moving parts are well oiled and carefully adjusted. There should be no backlash or slippage in any parts that will prevent the friction belt from being immediately moved when too heavy or too light a sliver is passing through the trumpet. The trumpet should be carefully regulated so that it will be in the correct position when the desired weight of sliver is passing through, and after it has once been balanced, care should be taken to keep it in its correct position.

In extreme cases in the North, there is a slight contraction in the trumpet during the night in winter, which affects the sliver slightly when first starting up in the morning, causing it to be a little lighter than the night before. This trouble is not experienced in the South, as the temperature is more even.

7. The draft of a railway head generally slightly exceeds the doublings. The gearing of the machine that has been illustrated is shown in Fig. 6, and the draft between the back roll and calender roll would be as follows with leather-covered top rolls, supposing the belt to be at the center of the cones:

$$\frac{2 \times 32 \times 24 \times 100 \times 60}{24 \times 45 \times 24 \times 30 \times 1\frac{3}{8}} = 8.619, \text{ draft}$$

8. The floor space occupied by a single railway head, such as has been illustrated, is 3 feet $3\frac{1}{2}$ inches by 5 feet 3 inches, while a double railway head occupies 6 feet $4\frac{1}{2}$ inches by 5 feet 3 inches. These dimensions allow for the space occupied by the cans placed at the back of the machine. The type of railway head illustrated weighs,



60
26
1⅜" Dia.
Back Roll
100
30
Change Gear
33
28
1⅛" Dia.
20
1⅛" Dia.
40
32
28
43
24
24
20
1⅜" Dia.
Front Roll
8"×1½"
45
32
2" Dia.
Calender Roll
24
12
16
16
24
40
100
33
33
12
9
60

FIG. 6

approximately, 1,200 pounds per delivery, while about 1 horsepower is required to drive three deliveries.

9. The speed of the front roll of a railway head may be from 300 to 500 revolutions per minute for a $1\frac{3}{8}$-inch roll. The production at 400 revolutions with a 50-grain sliver, making an allowance of 20 per cent. for stoppages, is about 165 pounds in a day of 10 hours; with a 60-grain sliver, about 200 pounds; and with a 70-grain sliver, about 235 pounds.

10. Another type of evener motion, and one that is more commonly found on railway heads, has the cones situated under the roll beam. These cones, which are considerably larger than those in the railway head previously described, are about 13 inches long, $7\frac{1}{4}$ inches in diameter at the large end and 5 inches at the small end, although they vary in different makes. Fig. 7 shows the gearing of the machine under description. The driving pulley is on the shaft with the top cone, while on the other end of this shaft is a gear that drives the front roll by means of carriers; consequently,

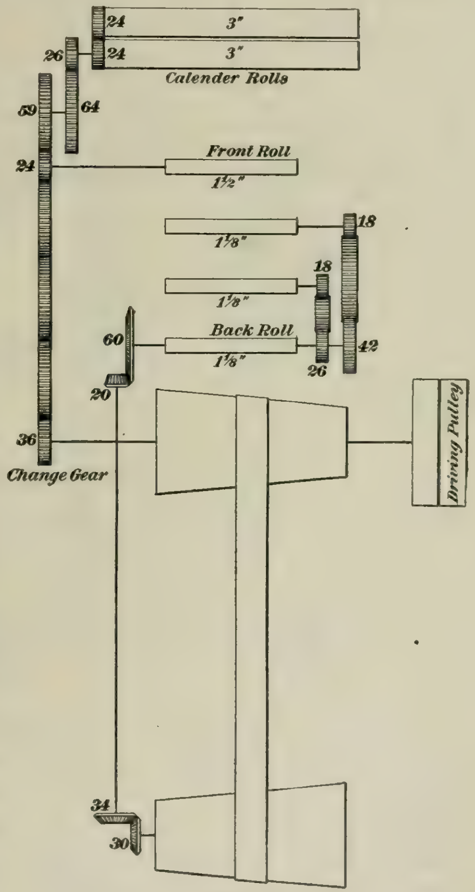


FIG. 7

the front roll is always driven at a constant speed. On the end of the bottom-cone shaft is a bevel gear driving another bevel on an upright shaft that drives the back roll. The third and second rolls are driven from the back roll.

The calender rolls and coiler are driven from the front roll, while the cone belt is required to drive the second, third, and back rolls. Since these rolls are driven through the cones, their speed will depend on the position of the cone belt on the cones and, as in this motion the amount of friction on the trumpet determines the position of the belt on

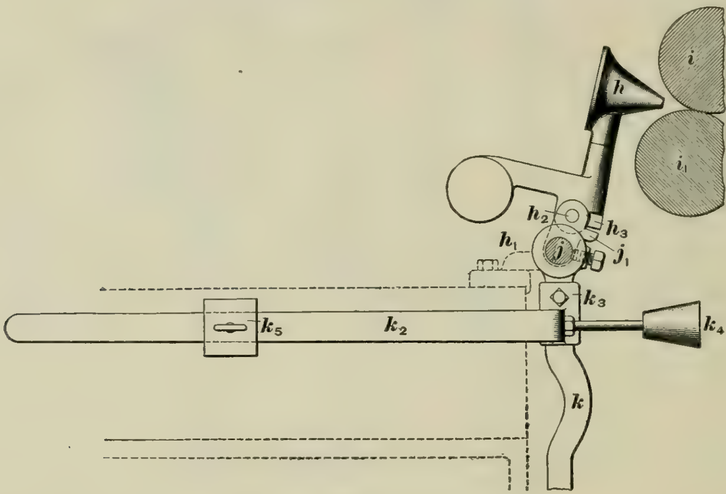


FIG. 8

the cones, the second, third, and back rolls are driven at varying speeds, in order to regulate the weight of the sliver delivered.

Fig. 8 shows a side view of the trumpet and its connections, while Fig. 9 shows two views of the cones and their connections, (*a*) being a back view and (*b*), a side view. The cone belt *a*, Fig. 9 (*a*), is moved along the cones *b*, *b*, by means of a shipper fork *c* that is cast with a hub c_1, which contains a coarse thread to engage with the thread of the shipper, or evener, screw c_2. Any motion given to this screw will therefore alter the position of the cone belt

on the cones. The evener screw has a bearing, or support, in brackets attached to the framework and carries at one end a small gear c_3, Fig. 9 (*a*) and (*b*), that is driven by a gear *d* operated by the pawls e, e_1, which are mounted on the arm e_4 of a casting e_2 that is pivoted at e_3. Another arm e_5 is connected by means of a crank-motion to the gear *f*, which is

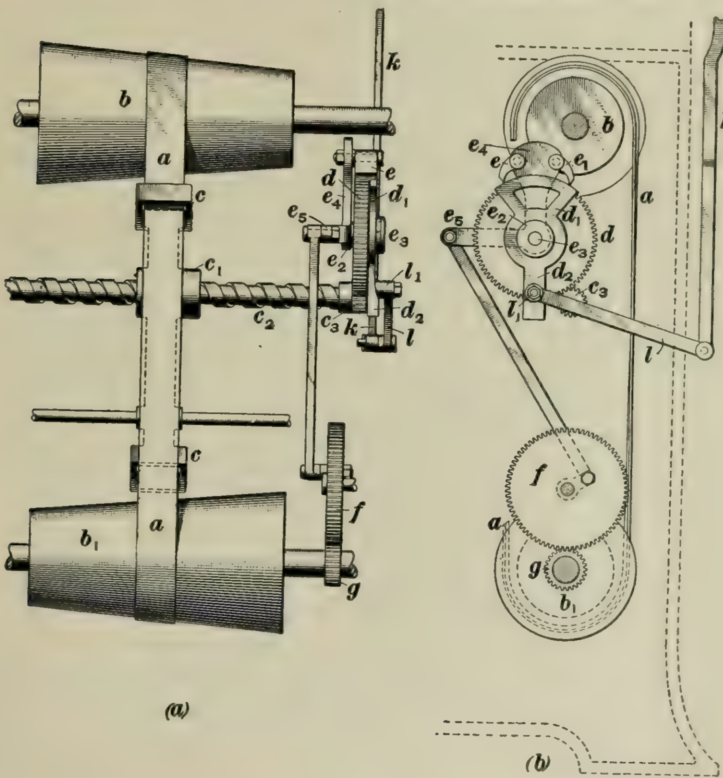


FIG. 9

driven from the gear *g* on the bottom-cone shaft. As the gear *f* revolves it causes the crank-motion to impart an oscillating motion to the bracket, or casting, e_2, thus causing the pawls to rock back and forth. When the weight of the sliver is running even, the pawls are kept out of contact with the gear *d* by means of the guard plate d_1.

Referring to Fig. 8, the bracket h_1, that is attached to the roll beam, supports the trumpet h, which is pivoted at the point h_2. Thus the amount of friction caused by the sliver passing through the trumpet is allowed to regulate the relative position of the trumpet with regard to the calender rolls i, i_1. When the trumpet is drawn forwards by the friction of the sliver, the lug h_3 on the trumpet comes in contact with the lug j_1 on the shaft j. As the amount of friction increases or decreases, the lug h_3 will exert more or less pressure on j_1, thus giving a slight motion to the shaft j.

As the arm k is setscrewed to the shaft j, any motion of the shaft will be imparted to the arm, thus causing the lower end of the arm to swing. A balance arm k_2 fastened to k by a shoulder k_3 carries balance weights k_4, k_5. The latter, which is adjustable, can be moved along the arm k_2 to regulate the weight of the sliver to be delivered. At its lower end, the arm k is connected to a rod l, Fig. 9 (b), that is connected at the point l_1 to the arm d_2, the latter being a part of the casting carrying the guard plate d_1. When the shaft j is moved by the movement of the trumpet, it will move the lower end of the arm k in or out, and thus give a rocking motion to the casting carrying the guard plate d_1, which is pivoted at e_3.

When the sliver is too light, the trumpet will fall away from the calender rolls and cause the arm k to move outwards, thus exposing the teeth of the gear d to the action of the pawl e_1, which will cause the evener screw c_2 to move the belt to the large end of the top or driving cone, thus increasing the amount of cotton fed in and making the sliver heavier. When the sliver is too heavy, the action will be reversed.

The floor space occupied by a single head of this type is about 3 feet 2 inches by 5 feet 10 inches, allowing for the space occupied by the cans at the back. The weight is about 1,150 pounds, and $\frac{3}{4}$ horsepower is required to drive it, while a double head occupies a space of about 6 feet 3 inches by 5 feet 10 inches, the weight being about 2,000 pounds, and about $1\frac{1}{4}$ horsepower is required.

Owing to the objects and construction of railway heads and drawing frames being somewhat similar, the management of railway heads resembles that of drawing frames. Information on this subject can be obtained later in this Section, where the management of drawing frames is fully dealt with.

DRAWING FRAMES

INTRODUCTION

11. The **drawing frame** is the last machine in which any extensive correction of the unevenness of the sliver takes place. It usually follows the railway head in mills that use the latter machine, except when the stock is to be combed, in which case it follows the comber. In the most common arrangement of machines, the railway head is omitted and the drawing frame follows the card, except when combed yarn is being made, when it follows the comber.

The objects of the drawing frame are: (1) to lay the fibers parallel; (2) to correct, as far as possible, any unevenness in the sliver. These objects are accomplished: (1) by drafting, which by pulling the fibers past one another tends to make them lie in a parallel position; (2) by doubling, which has a tendency to even the resulting sliver.

12. Number of Drawing Processes.—At least two processes of drawing will be found in almost every mill; that is, a number of cans of sliver that are made at the front of one drawing frame will be placed at the back of another frame and run into one sliver at the front of this second frame. The number of drawing frames through which the cotton is passed is governed by the class of work to be produced and the number of preceding processes through which the cotton has passed. If the sliver comes direct from the cards there are usually two processes for coarse counts, three for medium counts, and four for fine counts. If the sliver has passed through the railway head, each of the above

number of processes is reduced by one process. If the sliver has passed through the sliver- and ribbon-lap machines and the comber, there are generally only two processes unless for very high counts, when three, and even four, are used.

When four processes of drawing are used, the machine that receives the sliver first is called the *breaker*, while the others are named in order *first intermediate*, *second intermediate*, and *finisher*. With three they are called breaker, intermediate, and finisher, while two are designated as breaker and finisher. The four processes are also known as *first*, *second*, *third*, and *fourth drawings*.

13. Arrangement of Drawing Frames.—Drawing frames are generally placed directly in front of each other, the usual method being to place the cans from the card, comber, or railway head, as the case may be, at the back of the breaker drawing frame, and as the sliver is delivered at the front, the full cans are taken and placed at the back of the next drawing frame, this system being followed throughout the processes of drawing. Where the floor space is limited, the frames may be placed in a line instead of in front of each other, in which case the alternate drawing frames face the same way. For instance, where three processes of drawing are used, the cotton is passed through the breaker drawing frame situated at the end of the line. The cans from the breaker are then taken to the intermediate, which is facing in a direction opposite to that of the breaker drawing frame, while the cans from the intermediate are taken to the third drawing frame, which is at the other end of the line and has its delivery on the same side as the delivery of the breaker drawing frame.

GENERAL CONSTRUCTION

14. Fig. 10 shows a view of the front of a drawing frame, the construction of which very closely resembles that of a railway head, with the exception that no evener motion is attached. One complete drawing frame is called a **head.** Several heads, however, may be connected by one shaft and

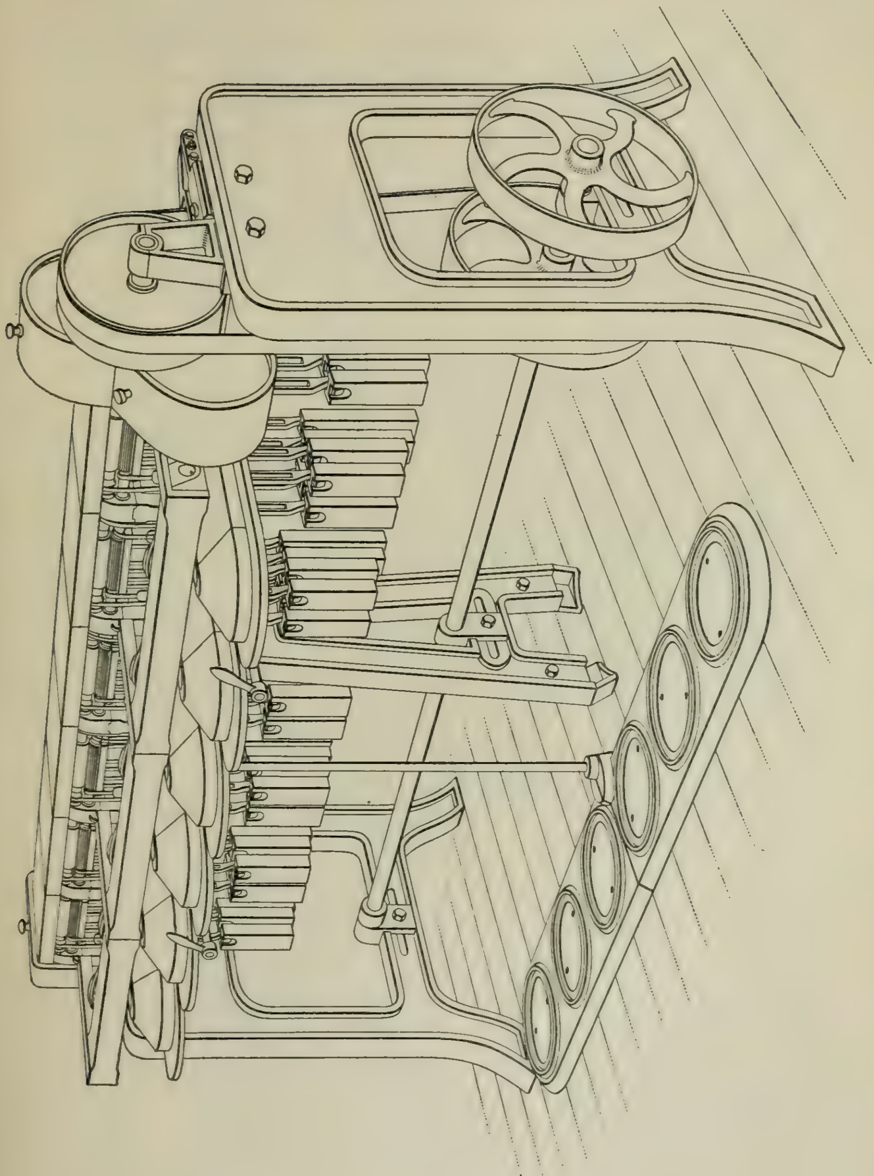
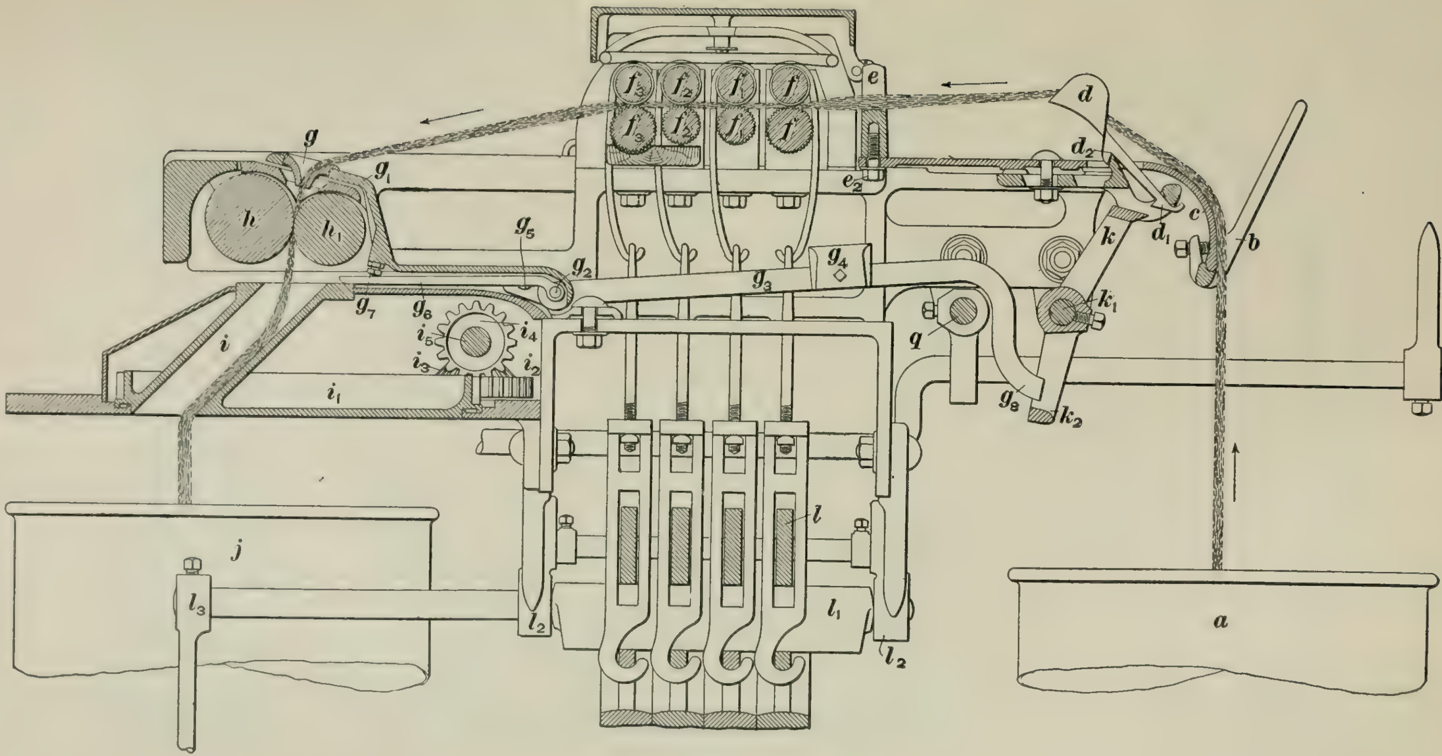


Fig. 10

still be called a drawing frame, or more accurately, a *line of drawings*. Each head consists of a number of deliveries, while each delivery has its own coiler and its own set of drawing rolls, which receive a number of slivers at the back, subject them to the desired draft, combine them into one sliver at the front, and deposit it in a can. For example, if four, six, or eight slivers side by side are passed through four sets of rolls and combined at the trumpet at the front of the machine into one sliver, that part of the machine is called a delivery, and a number, or set, of these deliveries is called a head.

A line of drawings usually consists of three heads, while a head may contain from four to eight deliveries. Fig. 10 represents a drawing frame with one head of six deliveries; if, however, the lower shaft were extended and another pulley mounted on it to drive another set of gearing, which in turn governed six other deliveries, it would represent a line of drawings consisting of two heads with six deliveries each.

Fig. 11 represents a cross-section of one delivery of the machine shown in Fig. 10; the arrows in this figure indicate the direction in which the stock passes through the machine. Usually six cans similar to a are placed behind each delivery, each sliver passing through the guide b, over the plate c, and the spoon d, there being one spoon for each sliver. The slivers next pass over another guide plate e and then to the four sets of rolls f, f_1, f_2, f_3, where the necessary draft is inserted. From these drawing rolls the slivers pass to the trumpet g, where they are combined into one, then through the calender rolls h, h_1, through the coiler tube i, and to the can j. The guide b consists of a number of fingers, between each two of which a separate sliver passes; in this manner the slivers are prevented from licking or splitting. The plate c is highly polished, thus preventing the fibers from adhering to it, while it also forms a cover for the working parts beneath. The guide e consists of a casting carrying two projecting lugs, the distance between which is about equal to the width of all the slivers passing through the



a
b
c
d
d1
d2
e
e2
f
f1
f2
f3
g
g1
g2
g3
g4
g5
g6
g7
g8
h
h1
i
i1
i2
i3
i4
i5
j
k
k1
k2
l
l1
l2
l3
q

FIG. 11

delivery. This guide is secured to the plate e_1 by two screws similar to e_2.

The drawing rolls are of the ordinary type; leather-covered top rolls are shown in this illustration, although for coarse work metallic rolls are generally preferred. The length of the top rolls for each delivery varies from 15 to 18 inches, while each bottom roll is generally made in one length for the whole head or, as in more modern construction, in sections pieced together so that they revolve as one roll. The top rolls are weighted in the manner usually adopted for weighting leather-covered rolls on drawing frames. The weighting arrangement is equipped with a weight-relieving motion, as shown at l, l_1, l_2, l_3. The draft inserted in the sliver by these rolls, though not arbitrary, is usually about equal to the number of doublings, thus producing a sliver at the front of about the same weight as each end fed in at the back.

The trumpet g is supported by the lever g_1 and derives its name from being trumpet-shaped. It occupies a nearly upright position, having the smaller part of the hole at the delivery end. The sliver enters the larger end of the trumpet and is condensed by being drawn through the smaller part. The calender rolls h, h_1 are smooth steel rolls extending along the machine parallel to one another, and to the front rolls. The rear roll h_1 is about 2 inches in diameter, while the front one h is slightly larger. These rolls are solid and self-weighted, and serve to condense the sliver and draw it through the trumpet g. Their surface speed is just sufficient to prevent any slackness of the sliver as it comes from the front rolls. The coiler connections at the front of the drawing frame are very similar to those attached to the card. The oblique tube i is connected to the plate i_1, which has teeth on its rim and is driven by the gear i_2; the gear i_2 is compounded with the bevel gear i_3, which is driven by the bevel gear i_4 on the shaft i_5. This shaft extends the entire length of the machine and has at each delivery a gear similar to i_4, which drives the gears that give motion to the coiler for that delivery.

15. The diameters of the cans into which the sliver is delivered at the front vary from 9 to 12 inches, advancing by inches, those generally used being 10 inches in diameter. In former years they were made wholly of tin, but those now used are generally made of a paper pulp, which has the advantage of being lighter and cheaper. Although lighter, they are more durable than the metal cans, and seldom show the principal defects of the latter type of can; namely, ragged edges and loosened or detached bottoms.

STOP-MOTIONS

16. The principal parts of a drawing frame that call for a somewhat more detailed description are those connected with the various **stop-motions.** If one of the cans at the back should become empty or if one of the slivers should break before reaching the back rolls and the machine should continue to run, the reduced weight of the sliver delivered at the front would tend to produce unsatisfactory work at the later processes. As it is of vital importance to have the sliver that comes from the drawing frame of a uniform weight, devices are applied to stop the machine when an end breaks or runs out at the back. Additional motions are also applied to stop the machine when the sliver breaks between the front rolls and calender rolls, when the cans at the front of the machine become full, and in some cases when any part of the cotton laps around the calender or the drawing rolls. There are two general classes of stop-motions applied to drawing frames—*mechanical* and *electrical*. As the mechanical stop-motions are older and more commonly met with, they will be described first.

MECHANICAL STOP-MOTION

17. The method adopted to automatically ship the belt from the tight to the loose pulley and thus stop the machine will be described with reference to Figs. 11, 12, and 13, Fig. 12 being a plan view and Fig. 13 a sectional elevation, taken on line $x x$ of Fig. 12. The driving belt runs on the

tight and loose pulleys u, u_1, Fig. 12, and is governed by the belt guide r, which is fastened to the rod q and extends outwards above the spring s and shaft k_1. Working loosely on

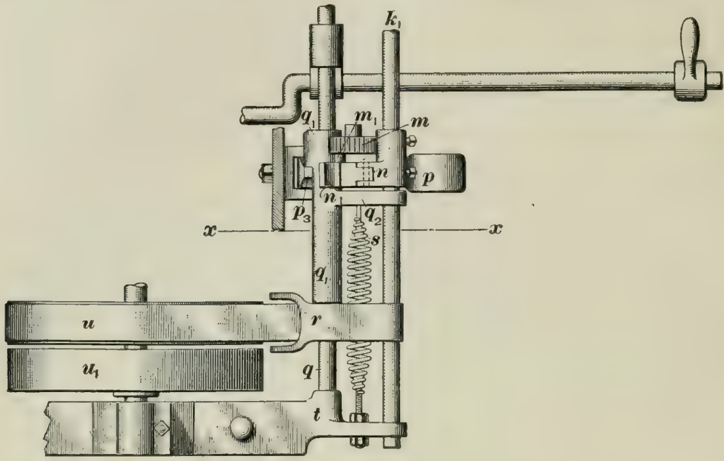


FIG. 12

this rod is the casting q_1, which is kept pressed against the belt guide by means of the spring s, one end of which is fastened to the bracket t, while the other end is connected to the arm q_2 of the casting q_1, this arm working loosely on the shaft k_1. By this means the casting q_1, unless held in position by some other mechanism, will force the belt guide r in such a direction that the belt will be shipped from the tight pulley u to the loose pulley u_1.

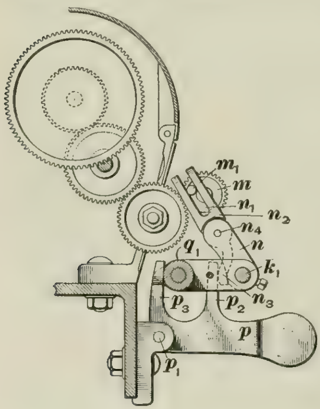


FIG. 13

The method adopted to hold the casting q_1 in position when the belt is on the tight pulley is more clearly shown in Fig. 13. Pivoted at the point p_1 is the casting p, which carries two arms p_2, p_3. When the machine is started by means of shipping the belt from the

loose to the tight pulley, the belt guide r, Fig. 12, carries the casting q_1 along with it as the shipper and rod move. The projection on the casting q_1 is beveled off on the side that comes in contact with p_3 when the belt is being shipped to the tight pulley. Thus the outer end of p is raised until the projection on q_1 passes the arm p_3, when it falls and allows p_3 to hold the casting securely in position. Set-screwed to the shaft k_1 is the knuckle-jointed lever n. The upper end n_2 of this lever contains a slot n_1, in which works a pin m_1, which is a part of, and revolves with, the gear m. Thus, as the gear revolves, the pin m_1 moves the upper end of the lever alternately backwards and forwards, which imparts an oscillating motion to the shaft k_1, provided that this shaft is free to oscillate, since under these conditions the fulcrum of the lever will be at the point at which it is attached to the shaft. If, however, the shaft k_1 is prevented from oscillating, the fulcrum of the lever will be at the point n_4, and as the part n_2 is forced out by the pin m_1, the arm n_3, which is a part of n_2, will be forced against the arm p_2, pushing up the casting p, since it swings on p_1, and allowing the arm p_3 to release the casting q_1.

18. Drawing frames equipped with the **mechanical stop-motions** automatically stop when the sliver breaks or runs out at the back, when the sliver breaks in front, and when the cans at the front become full.

The manner in which the machine is stopped when a sliver at the back breaks or runs out is described with reference to Figs. 11, 12, and 13. Referring to Fig. 11, it will be noted that each sliver passes over a guide d, known as a **spoon,** that is supported at the point d_2 but is free to swing up and down, its lower end being slightly heavier than its upper end. The weight and tension of the sliver in passing over the spoon is sufficient to lower the upper end of the spoon. Should the sliver break or run out, however, the spoon will be released, its lower end will drop, and the projection d_1 will engage with a projection on the arm k, which being set-screwed to the shaft k_1 oscillates with that shaft. As the

projection d_1 engages with the projection on the arm k, the shaft k_1 is prevented from oscillating, thus causing the arm n_3, Fig. 13, to be forced against p_2, bringing p_3 out of the path of q_1, and allowing the spring s, Fig. 12, to force the casting against the belt guide, shipping the belt from the tight to the loose pulley and stopping the machine.

19. The mechanism that stops the machine in case the sliver breaks between the front rolls and calender rolls is as follows, reference being made to Fig. 11. A lever g_3 that is pivoted at g_2 carries a weight g_4 that tends to lower the outer end g_8. At its forward end the lever g_3 carries a lug g_5 that bears against the lever g_6, which in turn bears against an adjusting screw g_7 carried by the lever g_1 that supports the trumpet g. In case the sliver is running through the trumpet properly, the weight and tension of the sliver is sufficient to cause the lever g_1 to hold down the lever g_6; and since this lever rests on the lug g_5, the weight g_4 will be prevented from lowering the outer end g_8 of the lever g_3. On the other hand, if the sliver breaks at the front of the machine, the outer end of the lever g_3 is forced down by the weight, and the part g_8 comes in contact with the front of the projection k_2 on the arm k, which action prevents the shaft k_1 from oscillating and stops the machine in the manner previously described.

20. When the can j, Fig. 11, is filled, the sliver gradually presses the plate i_1 up, forcing the upper end of the tube i against the lever g_6, which allows the weight g_4 to force g_8 into the path of the projection k_2, thus stopping the machine in the same manner as when the sliver breaks at the front.

ELECTRIC STOP-MOTIONS

21. Introductory.—A principle that has been extensively applied to drawing frames is that of automatically stopping the machine through the use of electricity. But in considering **electric stop-motions** it will first be necessary to give some attention to certain laws of electricity that

make it possible to apply this class of stop-motions to cotton-mill machinery.

The electric current must always be generated by some suitable apparatus, which for stop-motions on drawing frames generally consists of a dynamo placed above the frames. If suitable connections are made, an electric current will flow from one part of the dynamo through the connections and back again to the dynamo, forming what is known as a *circuit.* In order to have a current of electricity, there must always be a complete route, or circuit, from the source of the electric current through the various connections, and back again to the place from which it started. If there is more than one route that the current can follow, it will divide into two or more separate currents, but the maximum current will always flow through the path of the least resistance. If for any reason the circuit is broken, the flow of electricity will stop. The two ends, at the place where the circuit is divided, are known as *terminals*, one of which is termed positive and the other negative. That terminal from which the current would flow, if connected with the other terminal, is called *positive;* while the terminal into which the current would flow from the positive terminal is called *negative.*

Substances are divided into two classes as regards the resistance they offer to the flow of electricity, and are known as **conductors** and **non-conductors,** the former consisting of those substances through which an electric current can readily pass, while the latter comprises substances that offer great resistance to the flow. When two conductors come in contact, the current readily flows from one to the other. If it is desired to prevent this flow, the bodies must be *insulated;* that is, they must be separated by some substance that is a non-conductor. Metals are good conductors, while glass, silk, cotton, etc. are poor conductors. Thus, if a current of electricity is passing from one piece of metal to another, as, for instance, the top and bottom rolls of a drawing frame, and some non-conducting substance, such as cotton, is brought between the points of contact of the two pieces of metal, the circuit will be broken and the current stopped.

If a piece of soft iron is surrounded by coils of wire through which an electric current passes, the iron becomes magnetized and has the power of attracting certain other metals, such as iron and steel. A piece of iron magnetized in this manner is known as an *electromagnet.*

22. Operation of the Electric Stop-Motion.—Fig. 14 is a section of a drawing frame equipped with the electric stop-motion, while Fig. 15 is a portion of a front view of the same machine. The electric current passes from the dynamo through the rod a into and through the several parts of the machine and leaves it through the rod a_1 to enter the dynamo. As far as possible, the path that the current takes through the drawing frame has been indicated by means of arrows. Otherwise, those parts that are connected with the positive terminal of the dynamo are indicated by being cross-hatched in two directions, when in section, and by a dark surface shading, when not in section. Those connected with the negative terminal are shown in the ordinary manner.

It will be noticed that, with few exceptions, the whole frame of the machine with all the rolls, except one, are negative; this positive roll is marked m. Among the positively charged parts the most important are the cover p_1, back plate k_3, connecting piece k_2, roll m, rod k_1, and springs t, s.

It is of importance that the positively charged parts shall be electrically insulated from those negatively charged. This is attained by interposing plates or disks of insulating material between them. The presence of these insulating parts at any place is indicated in the drawings by means of full black surfaces. The action of the stop-motion depends on devices by means of which connections are made between the insulated parts, in order that an electric current may pass from one to the other.

The path of the electric current through the machine is as follows: From the rod a through the electromagnet b, b_1, then through the parts l, j, k, and the rod k_1 that extends across the frame. Electrically connected with this rod are two springs s, t, these springs being duplicated at each

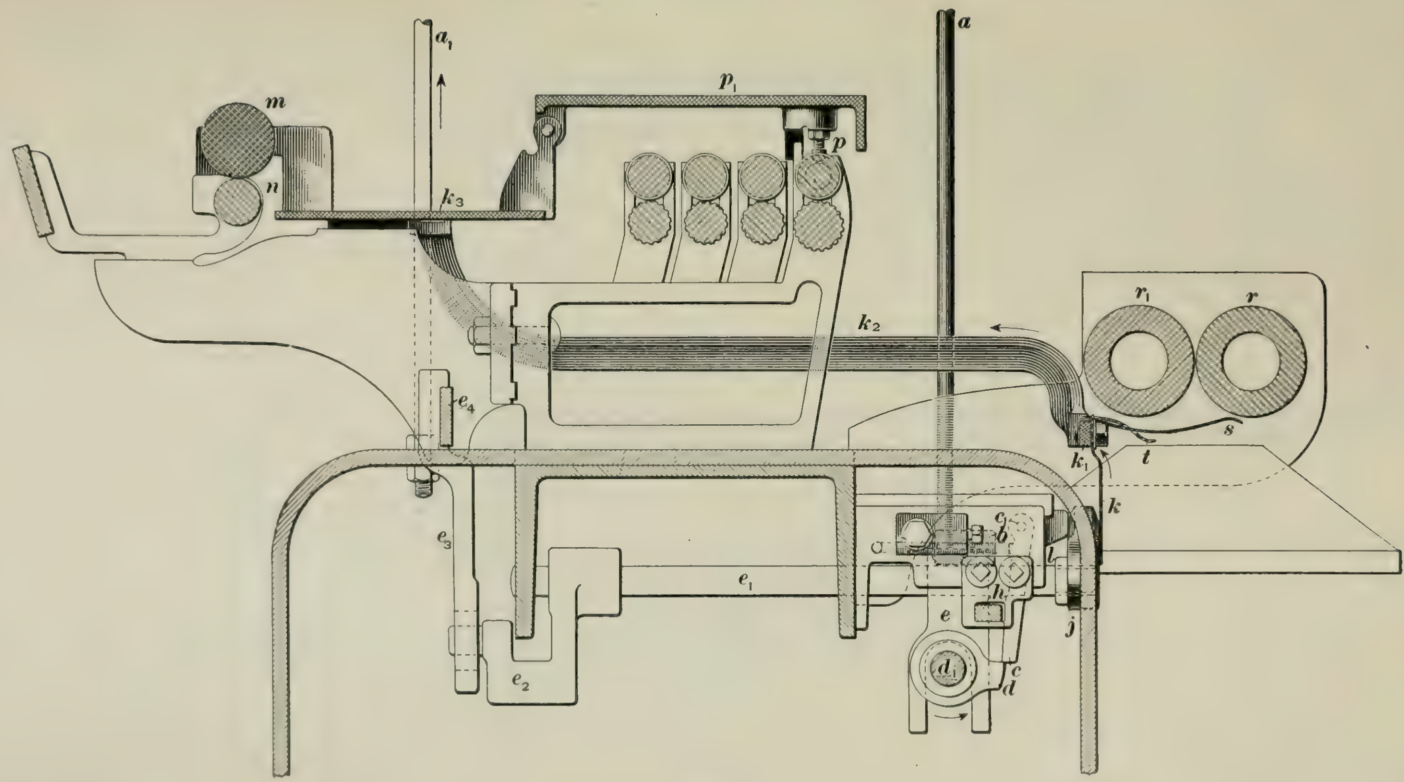


FIG. 14

delivery. From the rod k_1, the current passes through the connecting piece k_2 that extends to the back of the frame and forms a connection with the back plate k_3. From here the current passes to the cover p_1 and roll m.

It should be noticed that as long as the various parts are kept insulated from each other no electric current will pass through. It is only in case any one of the insulating plates is, as it were, bridged over that a current will flow. The current in all cases makes its start through the electromagnet b, b_1; this will therefore always be set in action first and will attract the small finger c. As this finger is pivoted at c_1 its lower part swings over, coming in contact with a dog d that is a portion of f, which, although loose on the coiler shaft d_1, ordinarily revolves with it, being driven by frictional contact with the part g, which revolves with the shaft d_1, since the surfaces of these parts that are in contact are at an angle with the shaft. The part g is on a keyway on the shaft d_1; consequently, it must revolve with the shaft, but is capable, however, of being pushed lengthwise of the shaft. As d and f are stopped by the finger c, the part g, continuing to revolve, will be pushed lengthwise of the shaft because of the shape of the parts f, g. This action of g throws the lever e to the right, which, since e is fastened to the shaft e_1, gives the latter a partial revolution. Setscrewed to the shaft e_1 is a casting e_2, an arm of which works in a slot in the upright rod e_3, which controls the shipper rod e_4 to which the belt shipper is attached. As the shaft e_1 is turned by the lever e, it throws the casting e_2 over to one side, moving the rod e_3 and, consequently, the shipper rod e_4 in such a direction that the belt will be shipped from the tight to the loose pulley.

The action of the rod h should be noted in this connection. As the lever e, to which it is fastened, is forced over by g, it brings with it the rod h, which is so shaped that it forces the finger c out of contact with the revolving dog d, thus placing these parts in their initial positions.

Drawing frames equipped with the electric stop-motion shown in Figs. 14 and 15 stop when the sliver breaks or

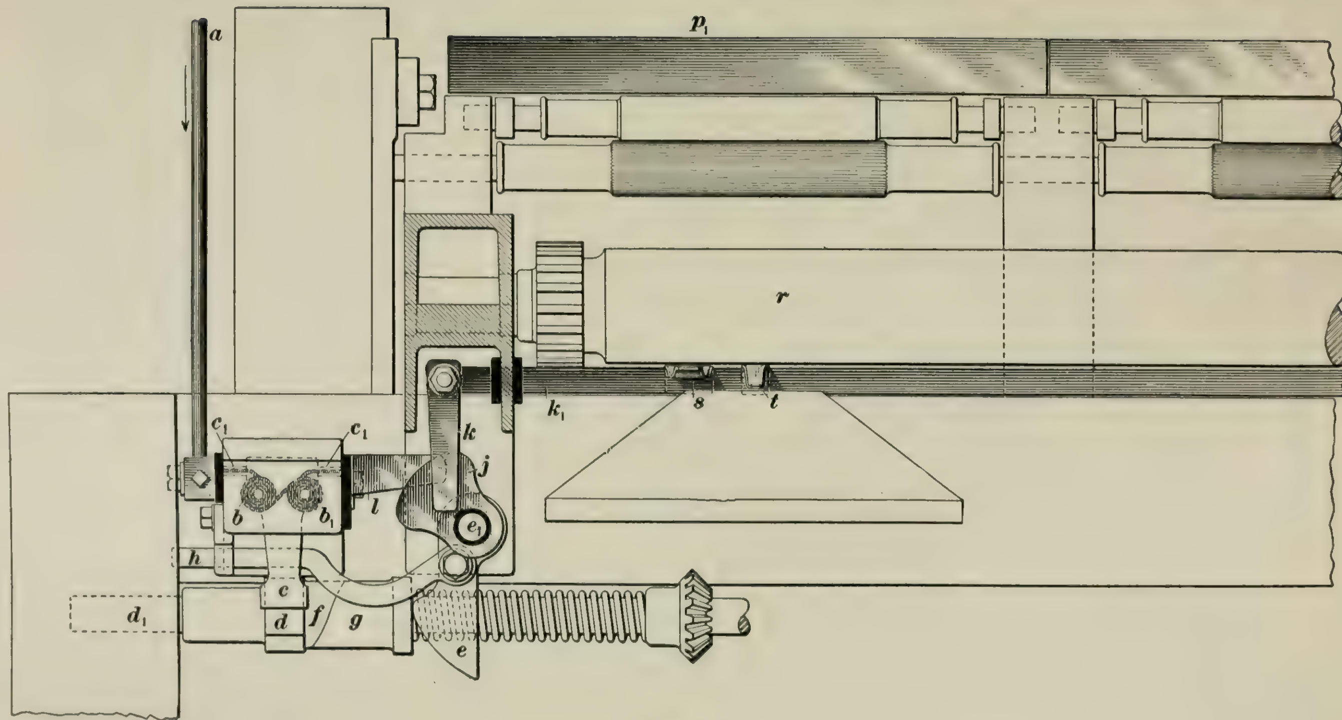


FIG. 15

runs out at the back, when laps form on the top or bottom front drawing rolls, when the sliver breaks in front, and when the cans at the front become full.

23. The rolls *m*, *n* are known as the *top* and *bottom preventer rolls*, respectively; they are also sometimes called *detector rolls*. They are frequently found applied to both railway heads and drawing frames, and are considered an advantage both in working the stop-motion when an end breaks or runs out at the back and in making a piecing at the back. With these rolls, the tension on the sliver is more even, thus keeping the spoons in their correct position and causing the stop-motion to act more quickly. A piecing at this place is desirable since, as it does not require tall help to run the frames, small boys, girls, or women may be employed, whereas when the piecing must be made close to the back rolls taller help is required.

As shown in Fig. 14, the roll *m* is positive, while *n* is negative; consequently, if these rolls are allowed to come in contact, a circuit will be formed and the machine stopped. The lower roll *n* extends the entire length of the machine, while the top roll *m* is made in shorter lengths, there being one of these rolls for every two slivers at the back. As long as the slivers are passing between these two rolls they are prevented from coming in contact. Should either sliver break or run out, however, the end of the roll under which it passes will drop and, coming in contact with the lower roll *n*, will form a circuit and stop the machine. By referring to Figs. 14 and 15, it will be seen that the drawing rolls are negative and the covers positive. The front top roll rests in bearings and is capable of being raised if any obstruction comes between it and the bottom roll. Fastened to each cover of the drawing frame are two adjustable screws, similar to *p*, that are so set that they will not come in contact with any part of the rolls so long as the cotton is running through the machine properly. If the cotton laps around either the top or bottom roll, the increased size of the bulk of cotton between the two rolls will cause the top

roll to be raised in its bearings until it comes in contact with one of the screws p, when a circuit will be formed and the machine stopped.

The back calender roll r_1 extends the entire length of the frame, while the front calender roll r is made in sections, each of which is only long enough to serve for two deliveries and rests in inclined bearings. As long as the cotton is passing between the rolls, the thickness of the sliver will push the roll r up slightly in its bearings. However, should either sliver that passes between any one of the front calender rolls and the back calender rolls break, the end of the front calender roll that was supported by that sliver will drop and come in contact with the spring s. As one of these parts is negative and the other positive, a circuit will be formed and the machine stopped.

As the can at the front of the machine becomes full, the pressure of the sliver in the can raises the top of the coiler until it comes in contact with the spring t, when the machine will be stopped, owing to a circuit being formed by the contact of these two parts, one of which is positive and the other negative.

GEARING

24. Each head in a drawing frame is driven separately from any other head in regard to its individual gearing, but all the heads are driven by what is called the lower or main shaft, which runs underneath the frame; this shaft is shown in Fig. 10, and also in Fig. 16, which is a plan of the gearing of the machine similar to that shown in Fig. 10. At each head is a pulley that is connected with a tight-and-loose pulley on the front roll of that particular head by means of an open belt. The lower or main shaft is driven from the main shaft or countershaft of the room.

Referring to Fig. 16, a gear of 24 teeth on the front roll drives, by means of suitable gearing, the calender rolls and the coiler connections. Another gear of 24 teeth, situated on the front roll, drives the back roll. The gear of 26 teeth on this back roll drives the third roll. Thus, the draft

between these two rolls is constant, provided that the gears connecting the rolls are not changed. The wide-faced gear of 60 teeth on the back roll drives, by means of a carrier, the gear *m*, shown in Fig. 13 but not in Fig. 16. The gear

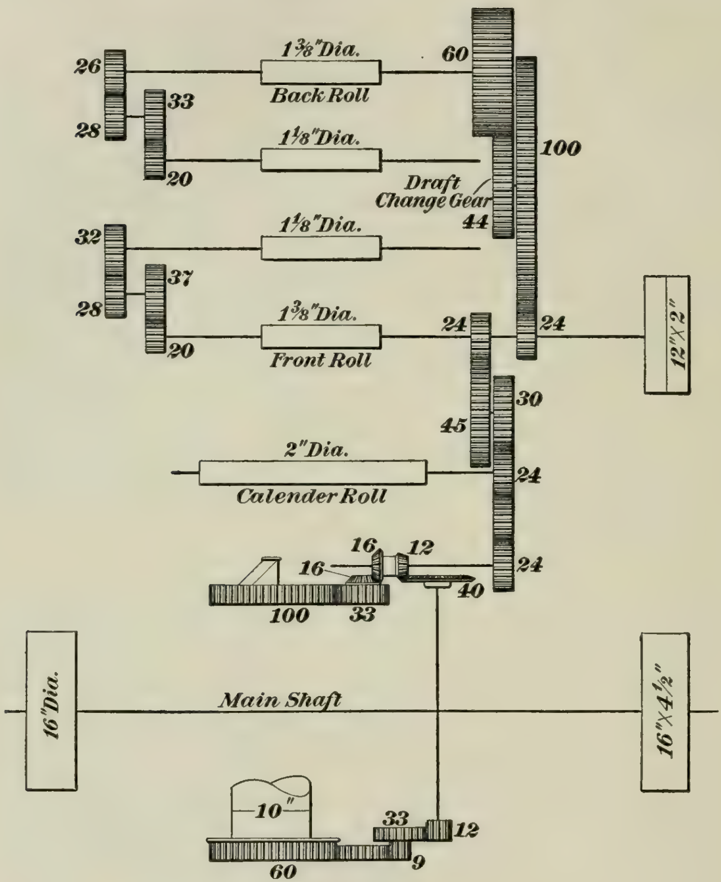


Fig. 16

of 20 teeth on the front roll drives the second roll, and consequently the draft between these two rolls is constant, provided that the gears connecting them are not changed. Thus it will be seen that the break draft of this machine comes between the second and third rolls.

The draft of a drawing frame with common rolls, and geared as shown in Fig. 16, would be as follows, the draft being figured from the calender roll to the back roll:

$$\frac{2 \times 30 \times 24 \times 100 \times 60}{24 \times 45 \times 24 \times 44 \times 1\frac{3}{8}} = 5.509$$

MANAGEMENT OF DRAWING FRAMES

25. The arrangement of the cans at the back of the frame is an important point to be considered. The usual practice is to place full cans of sliver behind the breaker drawing frame. This is all right for the breaker, as there is never the same amount of sliver in the different cans, due to the cards or combers being separate; therefore, the cans will be emptied at different intervals, thus insuring that no two piecings will come together and that the frame will not remain stopped for any length of time waiting for the attendant to piece more than one end. This, however, is not the case with the first and second intermediates and finisher, since in this case if a sliver breaks the whole head is stopped, and consequently when one can is full they are all full, if empty cans were inserted at the front at the same time; and if they are all taken out at once and fed immediately to the next machine at the same time, it is evident that they will all be emptied at about the same time, necessitating several piecings in a short length of sliver. To remedy this defect, it is better to feed the frames in sections so that some of the cans at the back of any drawing frame will be full, others three-fourths full, still others half full, and so on.

26. The relative weight per yard of the sliver delivered to the weight per yard of each sliver fed, depends on the relation of the number of ends fed, or doubled, at the back of one delivery to the total draft of the machine. It is the general plan in the drawing frame not to have the draft exceed the doubling. That is, if 6 ends are put up at the back of each delivery, the draft is not generally more than 6.

27. Both top and bottom metallic rolls should receive careful attention to prevent licking, which is frequently

caused by the flutes collecting and holding the dirt. On this account metallic rolls require cleaning oftener than common rolls.

Where common top rolls are used, they should be relieved of the weights if a stoppage occurs for more than 48 hours. This helps to prevent the leather top rolls from becoming fluted.

28. Before the leather top rolls are put into the drawing frame, they must be varnished, the frequency of subsequent varnishing depending on the varnish used, the weight of sliver produced, and the speed at which the rolls are run. Any roughness on the surface of these rolls causes licking, and careful attention should therefore be given to them, as licking produces waste, light sliver, and loss in production through stopping the head to remove roller laps. Any top roll that shows impressions of the flutes of the bottom steel rolls on the leather, or becomes fluted, as it is called, should be immediately recovered.

29. Sometimes in changing from coarse to fine work, or, in other words, from a heavy to a light sliver, the trumpet must be changed. This is on account of the sliver being so light and the small end of the trumpet so large that the friction and weight of the sliver will not be sufficient to keep the trumpet in its proper position, thus causing the frame to be stopped continually.

30. There should be very little waste made at the drawing frame, so that if a large amount is made it may be taken as an indication that some part of the frame is not properly adjusted, or that the operators are not attending to their work as they should. The drawing frames should be kept free from dirt, dust, and short fiber. Oil should not be allowed in places where it is not required. In order to insure clean work the tenders should wipe or brush the frames about every two hours; this takes very little of their time but greatly helps to improve the quality of the yarn. A thorough cleaning of all parts of the frame should take place twice a week.

All bolts, nuts, screws, etc. should be looked after and kept tight. Stop-motions should be kept in working order, as otherwise a great deal of bad work will result. All quickly moving parts, such as the top and bottom rolls, lower shaft, etc., should be oiled twice a day, and every moving part of the frame should be oiled once a week, care being taken not to get the oil on any surrounding parts that do not require oiling. The boxes of the lower shaft should be partially filled with tallow.

31. Weighing the sliver at the finisher drawing frame is a very important matter and should be done at least twice a day, while in fine work three, and sometimes four, times a day is advisable. If the weight of the sliver is properly adjusted at this point, there will be fewer changes in the subsequent processes. It is also best to have the stock running evenly as early as possible. The sliver is generally prepared for weighing by what is known as the measuring board, which usually consists of two boards 6 inches wide and 36 inches long hinged together on one of the side edges. One head of the frame is stopped and the cans at the front taken out. After it has been ascertained that all the ends are up at the back, the head is again started and run until about $1\frac{1}{2}$ or 2 yards has been delivered. The machine is then stopped and the ends of the slivers gathered together with one hand, while with the other hand they are broken off at the top. The slivers are now placed on one of the measuring boards, care being taken to have each sliver straight; the boards are then closed and the ends of the slivers projecting over the two ends of the board cut with a pair of shears or a sharp knife. The slivers are now taken from the board and weighed on a pair of scales. This weight is divided by the number of deliveries in a head, the result being the average weight of a sliver for that head. A variation of more than 2 grains over or under the standard for each sliver should not be allowed, and if this amount of variation is on the same side of the standard for two weighings, the draft gear should be changed. Sometimes the sliver from each delivery is

weighed separately instead of being taken as in the method previously described.

32. In connection with drawing frames equipped with an electric stop-motion care should be taken that all the metallic connections are screwed tightly together, in order that a circuit may be made and the machine stopped under any of the conditions previously mentioned. The preventer rolls should be kept free from oil, since if sufficient oil at any time collects on either of these rolls, it will form a film over the surface of the roll, and if under these conditions an end should break, thus allowing the top roll to come in contact with the bottom roll, the frame would not stop, as oil is a non-conductor and prevents the flow of the current. The contact springs between the calender rolls and coiler top should be kept clean and free from oil, in order that the current may not be prevented from flowing from one part to another when they come in contact. Care should be taken that positive and negative parts of the frame do not come in contact with each other when the cotton is passing properly through the machine, since the current will then return to the dynamo without passing through the proper channels, in which case the current is said to be *short-circuited.* Under this condition the stop-motion will not accomplish its purpose, and one of the two following things will happen: If the frame becomes short-circuited before the current reaches the magnet box, the stop-motion will not operate when an end breaks, since the current will be returned through the frame to the dynamo without passing through the magnet box. If the frame becomes short-circuited after the current has left the magnet box, the machine will be stopped, although the sliver may be running through the machine correctly. In order that the stop-motion shall operate quickly, which is very desirable, the finger that comes in contact with the revolving dog should be within $\frac{1}{16}$ inch of the dog when the machine is running.

33. Care of Drawing Frame.—The steel rolls should be carefully scoured at least once a month. Leather top rolls should be examined periodically so that the frames will not

continue to run with rolls that are fluted, channeled, or otherwise defective. Steel rolls that are not running true may occasionally be found by raising the top clearers and noticing whether any of the top rolls are jumping. The top rolls should be examined frequently to see that the varnishing is not neglected. The back of each frame requires watchfulness on the part of the one in charge to see that the right number of ends are being fed. Spoons should be examined periodically to see that they are well balanced and that the lower end drops immediately when the end of the sliver breaks or even when it comes through very light; the spoons should always work easily. Bad piecings should be looked out for, more especially those that are too long. If the drawing frame piecing is made 6 inches too long at the back, that amount of extra material will extend through many yards of the finished yarn. The guides at the back of the drawing frame should always be arranged so that the ends at the back will be separated as widely as the rolls will allow; bad drawing results if the ends are not spaced sufficiently far apart and one end rides on another.

Occasionally, drawing-frame tenders have been known to pass cans of material forwards without putting it through the frame. Where the frame that is skipped has a draft equal to the number of doublings, this does not make much difference to the ultimate weight of the yarn, but if the frame is one where a considerable alteration is made in the weight of the sliver, the omission becomes serious and causes irregular work. In any case, the practice should not be allowed.

The covers over the rolls should be examined daily by the one in charge—or even several times a day—in order to make sure that the tenders are picking off the clearer waste; this should be done every hour, for if the waste is left on the clearer, it is apt to be drawn forwards with the sliver and cause dirty slubs in the roving and unsatisfactory work at the future processes. The tenders should not be allowed to run the cans too full.

It should be remarked in connection with the drawing frame, as in connection with almost every other machine in

the mill, that high speeds do not always pay. There is a limit to the capacity of every machine, beyond which the work done deteriorates, or the excessive number of stoppages, through breakages and stock running out, prevents any advantage being gained by an excessively high speed.

In some cases, experiments have been made in connection with drawing frames in the direction of using fewer processes of drawing, in order to save labor cost. Drawing is not an expensive process as regards labor cost, and for this reason it is not advisable to use less than two drawing frames for numbers lower than 16s, unless the railway head is also used; not less than three drawing frames, or one railway head and two drawing frames, for numbers 16s to 70s; and not less than four processes of drawing for numbers finer than 70s, unless the sliver-lap and ribbon-lap machines are used in connection with the comber. These arrangements are not absolute and depend on the quality of the yarn desired.

In other cases, experiments have been made with a view to using extra processes of drawing so as to reduce the number of processes of fly frames where the labor cost is higher, but satisfactory results have not always been obtained.

34. The **floor space** occupied by a drawing frame similar to the one described and consisting of one head of six deliveries, is about 10 feet 6 inches by 5 feet 8 inches, allowing sufficient space for six cans at the back of each delivery. Drawing frames weigh, approximately, 700 pounds per delivery and, although the horsepower required to drive a frame varies somewhat with the class of work being run, it may be stated as a fair estimate that between four and five deliveries require 1 horsepower.

The speed of the front roll of a drawing frame may be from 250 to 700 revolutions per minute for a $1\frac{3}{8}$-inch roll. The production at 350 revolutions per minute with a 50-grain sliver, making an allowance of 10 per cent. for stoppages, is about 168 pounds in a day of 10 hours; with a 70-grain sliver, about 235 pounds; and with an 85-grain sliver, about 285 pounds.

35. It should be understood that the machines that have been described do not cover all the makes of railway heads and drawing frames, nor do the stop-motions and evener motions described in connection with the machines illustrated include all the different methods adopted to accomplish the same objects. However, it may be stated that the general principles of the different motions will be found to be similar, and if the descriptions given are fully understood, there should be no difficulty in tracing the action of any part of these machines that may be met with under different circumstances.

COMBERS

(PART 1)

COMBING EQUIPMENT

INTRODUCTION

1. When a cotton yarn is to be manufactured, it is first essential to select the grade of cotton that is suitable for the quality of yarn desired, after which it is necessary to determine the different processes that the cotton must pass through in order to obtain the required product. This usually means deciding whether or not the cotton shall be combed.

A lot of cotton, even if of the same grade, will never be found to contain an absolutely uniform staple, and the fibers that are below the average length will weaken the yarns spun from this lot. For very fine yarns, or for a high grade of yarn even when of coarse numbers, it is customary to adopt the processes of **combing** and those incidental to it; while for coarse or medium yarns, or yarns that are not required to be of superior quality, the picking and carding processes are usually considered sufficient for cleaning purposes. In these processes a large portion of the short fibers remain, but their presence in coarse and medium warp and filling yarns does not injure the quality to any great extent so long as the cotton selected is suitable; that is, generally speaking, in warp yarns that are not finer than 45s and filling yarns not finer than 90s.

2. Object of Combing.—For fine yarns it is essential that the short fibers should be removed, and to accomplish

this the process known as combing is introduced. Therefore, for warp yarns finer than 45s and filling yarns finer than 90s, or even for coarser numbers than these when a high grade of yarn is required, it is customary, in addition to the selection of the proper stock, to remove by the process of combing all fibers that are not of the required length. Combing, however, is an expensive operation, as considerable waste results from this process, and it is only profitable to comb when high-grade work is required.

3. In order to distinguish the different processes through which the cotton has passed, yarns are termed **carded yarns** and **combed yarns.** When yarns are spoken of as being carded, it may mean that they have been subjected to one process of carding or that they have been double-carded. Combed yarns may be single-combed or double-combed, and in either case they may have been carded once or twice, but double carding and double combing are not practiced to any considerable extent.

The process of combing is usually performed immediately after carding and before the drawing process, although in some cases one drawing process is used between the carding and the combing process. With the combing process a higher grade of yarn than that obtained with the carding process alone can be made from the same stock, or the same grade of yarn can be produced from a lower quality of stock.

4. A combing equipment usually includes three kinds of machines: (1) the *sliver-lap machine*, which has for its object the making of a lap from a number of card slivers; (2) the *ribbon-lap machine*, the object of which is to combine several of the laps from the sliver-lap machine into a firm and even lap; (3) the *comber*, the object of which is to remove all fibers that are under a length suitable for the yarn required.

When the drawing frame is introduced, the combing equipment generally consists of drawing frames, sliver-lap machines, and combers.

SLIVER-LAP MACHINE

CONSTRUCTION AND OPERATION

5. Before the cotton can be combed, it must be placed in a suitable form for the combing machine, and for this purpose it is taken in cans, either from the card or drawing frame, to the **sliver-lap machine,** an illustration of which is given in Fig. 1.

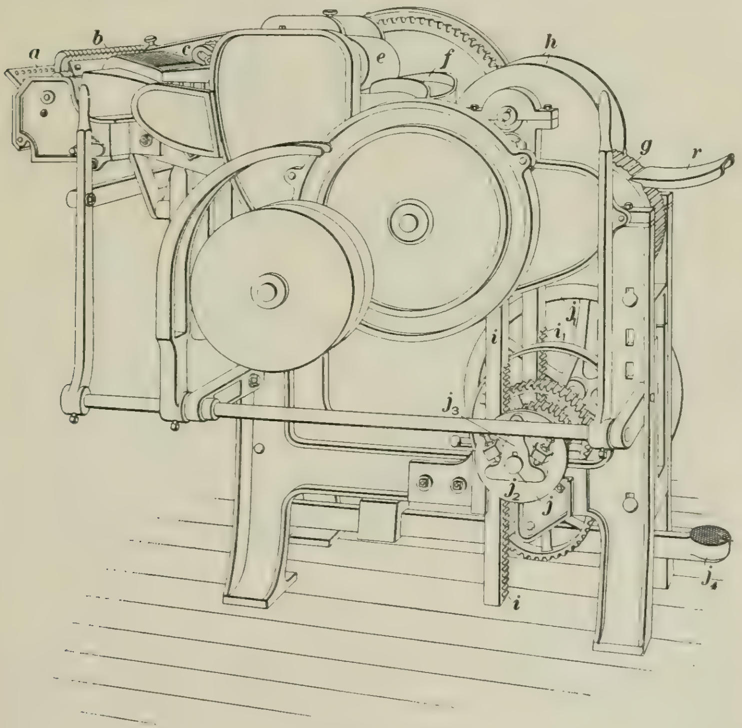


FIG. 1

From fourteen to eighteen cans of sliver are placed at the back of this machine, the number being governed by the width of lap required, which is usually $7\frac{1}{2}$, $8\frac{3}{4}$, or $10\frac{1}{2}$ inches. The slivers pass from the can, through a guide plate, over

spoons that operate a stop-motion, and then through a suitable conductor to the drawing rolls. In Figs. 1 and 2, *a* is the guide plate, *b* the spoons, and *c* the conductor. The drawing rolls *d* consist of three pairs of rolls, and are similar in construction to those of drawing frames. From the drawing rolls, the sheet of slivers passes between two pair of smooth calender, or presser, rolls *e*, where it is pressed into a uniform sheet. These rolls are solid and are usually 5 inches in diameter; the top rolls are weighted by means of weights

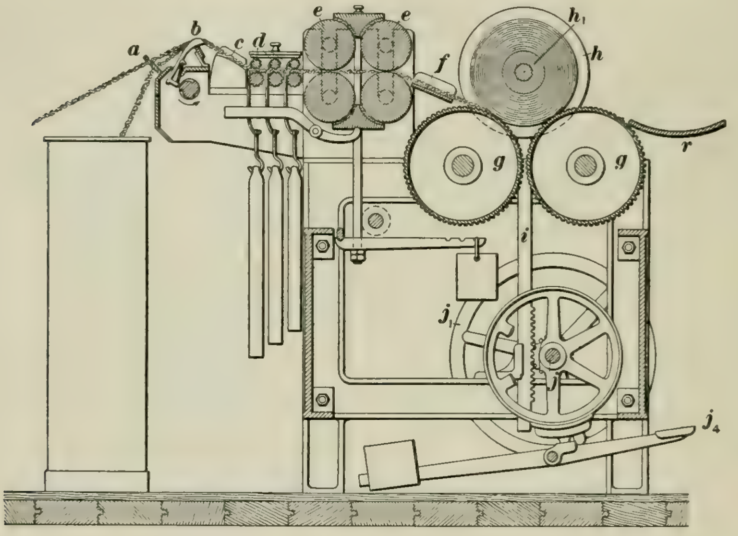


Fig. 2

and levers. The bearings of the top rolls are in vertical slots, thus allowing them to rise if an excessive amount of cotton comes between them and the bottom rolls. From the smooth calender rolls the cotton passes over a polished guide plate *f* with adjustable sides, and is then wound on a wooden roll, or spool, h_1, which rests on the fluted calender rolls *g*, and between the two plates *h*.

The wooden spool is made the width of the lap required, with a diameter of about 4 inches, and is held in position by a spindle passing through the hubs of the plates. On one

end of this spindle is a double thread, which screws into a similar thread on the hub of one of the plates. On the other end of the spindle is a collar and hand wheel, the distance from the collar to the thread being such that when the spindle is passed through the plates and spool and screwed up tight, the spool will be held firmly between the plates. The plates are supported by racks i, i_1, Fig. 1, the teeth of which engage with gears on the shaft j. The gear on the shaft j that engages with the rack i_1 is fastened to the shaft, while the gear engaging with the rack i is mounted on a sleeve that carries the disk j_2. This disk is secured to the casting j_3 in such a manner that it is adjustable, while the casting j_3 is keyed to the shaft j. This method of connecting the different parts provides a means of adjusting the rack i with relation to the rack i_1. When the racks are down in position, the spool rests between the upper parts of the calender rolls g and is in contact with both of them. The spool is usually made $\frac{1}{16}$ inch longer than the rolls, so that the plates will not bind on the edges of the rolls. As the fluted calender rolls revolve, the spool and plates revolve with them; by this means the sheet of sliver is wound on the spool and the lap formed. The diameter of the plates is greater than that of the full lap required, and, being in contact with the ends of the spool, the lap is built up the same width as the spool, with perfect sides.

A full lap should be from 12 to 14 inches in diameter, should have straight, smooth sides, and be hard and firm. To remove a full lap the friction is released by pressing down on the friction lever j_4 and the racks slightly raised by the hand wheel j_1 on the shaft j. The spindle is then removed by unscrewing it from the plate and withdrawing it from the spool, allowing the lap to be rolled on to the table r. The firmness of the lap is governed by the amount of friction placed on the friction motion of the racks; the smoothness of the sides, by the position of the conductor c and the adjustable sides of the guide plate f. The sides of the conductor c should be so adjusted that the sheet delivered to

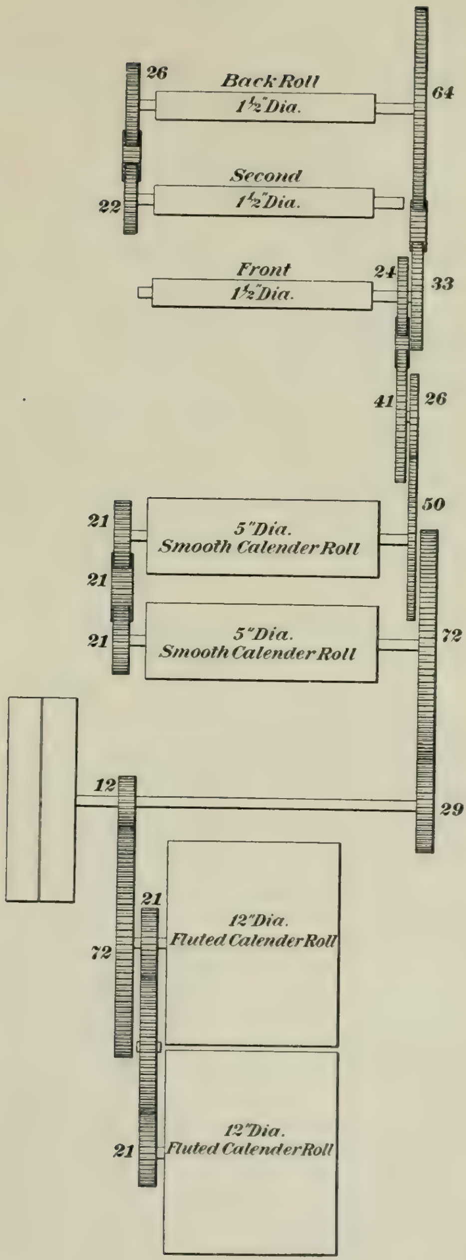
the calender rolls will be somewhat wider than the lap required. A selvage is formed on each side of the lap by the guide plate *f* and the circular plates *h*.

6. Stop-Motions.—There are two stop-motions, one to stop the machine when an end of sliver breaks at the back and the other to stop the machine when the lap is full.

7. The **sliver stop-motion** consists of unevenly balanced spoons *b*, the bottom ends of which are heavier than the top. Each spoon is so adjusted that the weight of the sliver holds down the upper part. When an end breaks and passes over a spoon, the spoon is released and the lower end comes in contact with a tumbler, or rocker. The shaft is stopped, and a catch on a shipper rod being released, a spring forces the rod outwards, causing the belt to be shipped to the loose pulley.

8. The **full-lap stop-motion** is operated as follows: As the rack is raised by means of the increased diameter of the lap, a dog on one of the racks comes in contact with a rod that extends back and connects with the catch on the shipper rod. As the dog passes the rod, it causes it to be moved backwards and releases the catch on the shipper rod. The dog is adjustable on the rack, so that different sizes of laps may be made.

9. Settings.—The setting points and adjustments on a sliver-lap machine are as follows: The proper adjustment of the stop-motion spoons, so that the spoon will act immediately when an end breaks; the regulation of the distances between the centers of the drawing rolls; the proper adjustments of the sliver conductor and guide plates so that a good selvage will be made; and the proper adjustment of the racks so that they will be perfectly plumb and level, since, if the racks are out of level, it will cause the plates to bind on the edges of the fluted calender rolls and will make an imperfect lap. The brake shoe on the friction motion also needs attention, and care should be taken not to allow oil to get on it.



26
Back Roll
1½" Dia.
64
Second
1½" Dia.
22
Front
1½" Dia.
24
33
41
26
50
21
5" Dia.
Smooth Calender Roll
21
21
5" Dia.
Smooth Calender Roll
72
12
29
21
12" Dia.
Fluted Calender Roll
72
12" Dia.
Fluted Calender Roll
21

FIG. 3

10. Fig. 3 is the plan of gearing for a sliver-lap machine; the draft, figured from the front fluted calender roll to the back drawing roll, is as follows:

$$\frac{12 \times 21 \times 12 \times 72 \times 21 \times 26 \times 24 \times 64}{21 \times 72 \times 29 \times 21 \times 50 \times 41 \times 33 \times 1\frac{1}{2}} = 1.954$$

The amount of draft is usually from 1.75 to 2.5. The weight per yard for a $7\frac{1}{2}$-inch lap for medium numbers is from 230 to 300 grains if it is to be used on the ribbon-lap machine, and from 200 to 250 grains if for use on the comber.

The 5-inch calender rolls of the sliver-lap machine make from 50 to 100 revolutions per minute, and the machine produces from 400 to 950 pounds per day, allowing 10 per cent. for stoppages. The weight of a sliver-lap machine is about 2,200 pounds, while the floor space occupied is about 5 feet $3\frac{1}{2}$ inches by 3 feet 1 inch. About 1 horsepower is required to drive it.

RIBBON-LAP MACHINE

CONSTRUCTION AND OPERATION

11. Object.—It is not absolutely necessary to use a **ribbon-lap machine** in the combing process, as the laps from the sliver-lap machine may be taken directly to the comber. If, however, the lap from the sliver-lap machine is unrolled for about a yard and held to the light, it will be seen that the slivers merely lie side by side, and that the lap is uneven, showing both thick and thin places. Therefore, to have a more even lap, the ribbon-lap machine is used. The usual doubling on the ribbon-lap machine is 6 into 1, and the laps fed are generally 1 inch narrower than the laps to be made for the comber.

12. A view of a ribbon-lap machine is shown in Fig. 4; Fig. 5 (*a*) and (*b*) shows sections through the machine. The laps from the sliver-lap machine are placed on the wooden rolls a, a_1, Fig. 5 (*a*), and the sheet passes over the plate b, which acts both as a guide and stop-motion. On the under

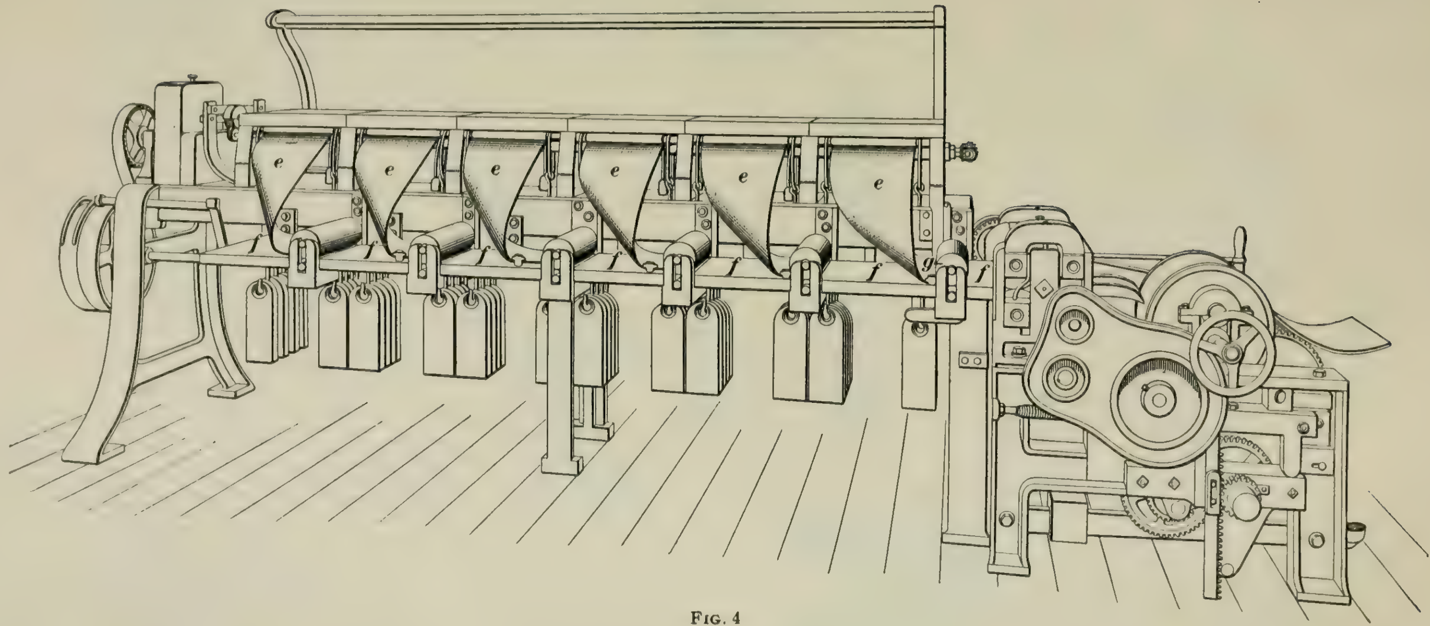


FIG. 4

side of this plate is a hook that acts similarly to the bottom part of the spoon described in connection with the sliver-lap machine. There is a slight draft between the wooden lap rolls and the back drawing rolls, and as the sheet of cotton passes over the plate *b*, the tension serves to hold it down. If the lap breaks or the spool runs empty, the plate rises and stops the machine.

The sheet passes from the plate *b* through the guides *c* to the drawing rolls d, d_1, d_2, d_3. The cotton then passes through

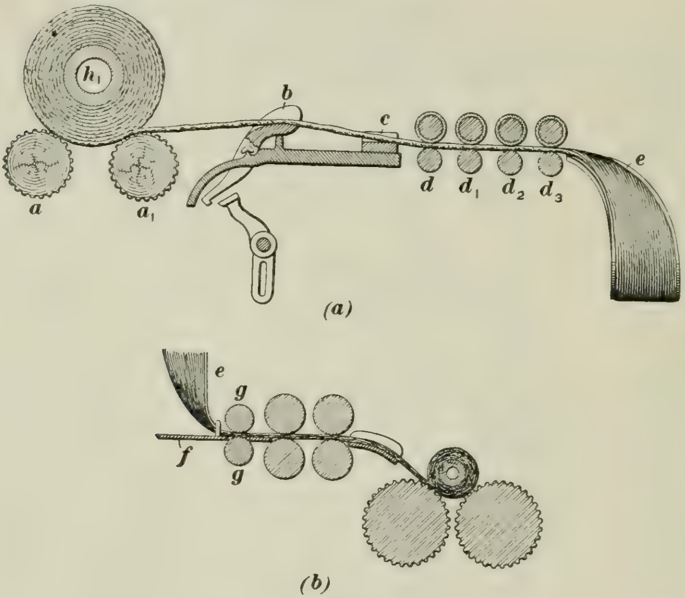


Fig. 5

these drawing rolls, of which there are usually four pair, the diameter of the first, third, and fourth, counting from the front of the machine, being $1\frac{1}{2}$ inches, and that of the second, $1\frac{3}{8}$ inches. The draft between the front and back drawing rolls usually about equals the doublings. The drawing rolls are constructed similarly to the rolls of drawing frames. The top rolls are weighted by dead-weights, two weights being used on each roll.

From the front drawing roll, the sheet of cotton passes over a curved plate *e*, Figs. 4 and 5, to the table *f*, along which it passes at right angles to the direction in which it passed through the drawing rolls. The cotton, in passing from the curved plate to the table, passes between the calender rolls *g*, which are known as the table calender rolls. In front of each pair a guide finger is placed on each side of the table to prevent the sheet from spreading. Each sheet, in passing from the driving end of the machine to the lap head, is carried under the sheet that is next to it in the direction of the lap head. The table calender rolls serve to condense the several layers of cotton into one sheet and to pass it forwards. From the last pair of table calender rolls, the sheet passes to the smooth calender, or presser, rolls of the lap head.

The curved plates *e*, over which the cotton passes from the drawing rolls to the table, are very highly polished. In some cases the plates are nickel-plated, and in others they are covered with thin sheet brass, sheet brass taking a better polish than cast iron, of which the plates are made. It is necessary that these plates be kept clean and polished, as the least particle of dirt or oil on the plates will cause the ends to break, and as there is no stop-motion on this part of the machine, it will continue to run until stopped by the attendant, thus causing uneven laps and considerable waste.

The lap head is constructed similar to the one on the sliver-lap machine, and the passage of the cotton through it is exactly the same as in the sliver-lap machine.

It is necessary that the table calender rolls, table, and lap head be perfectly level and in line; if they are not, there will be some difficulty in getting the several sheets to run to the lap head properly.

13. Settings.—The points of adjustment and setting are the same as on the sliver-lap machine. The plate for the stop-motion should be correctly balanced; the distances from center to center of the drawing rolls should be properly regulated; the guides should be so adjusted as to make the

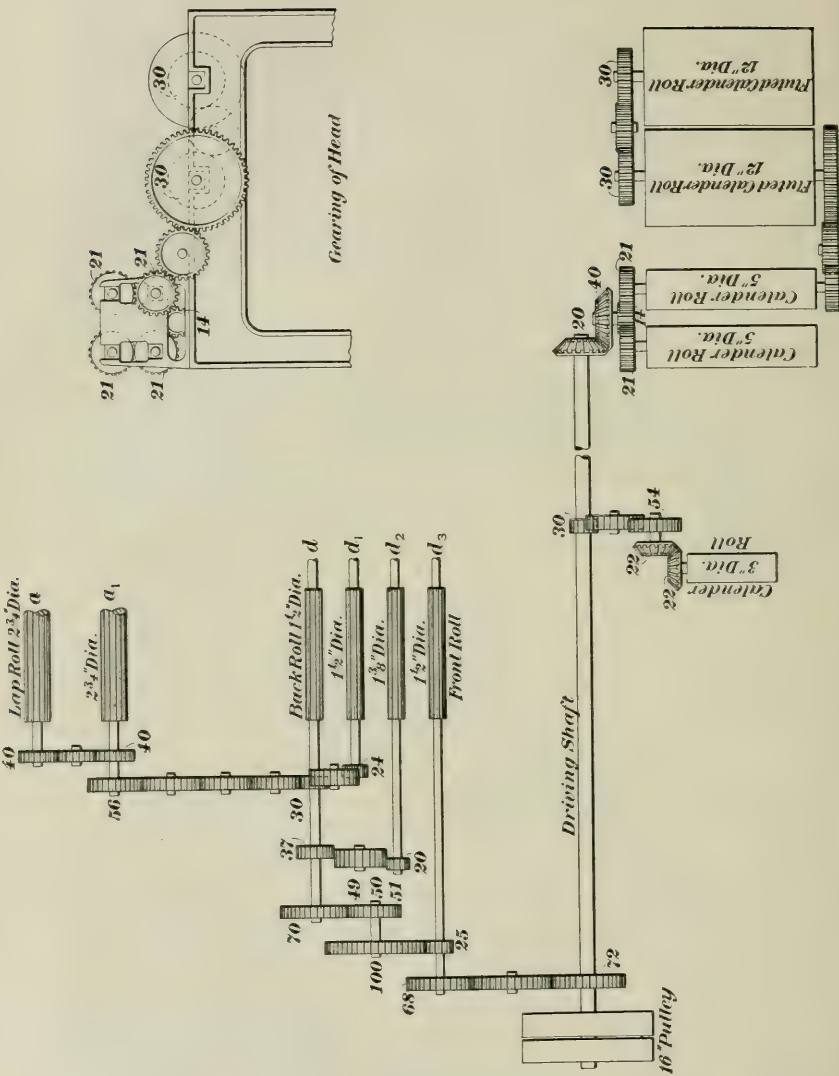
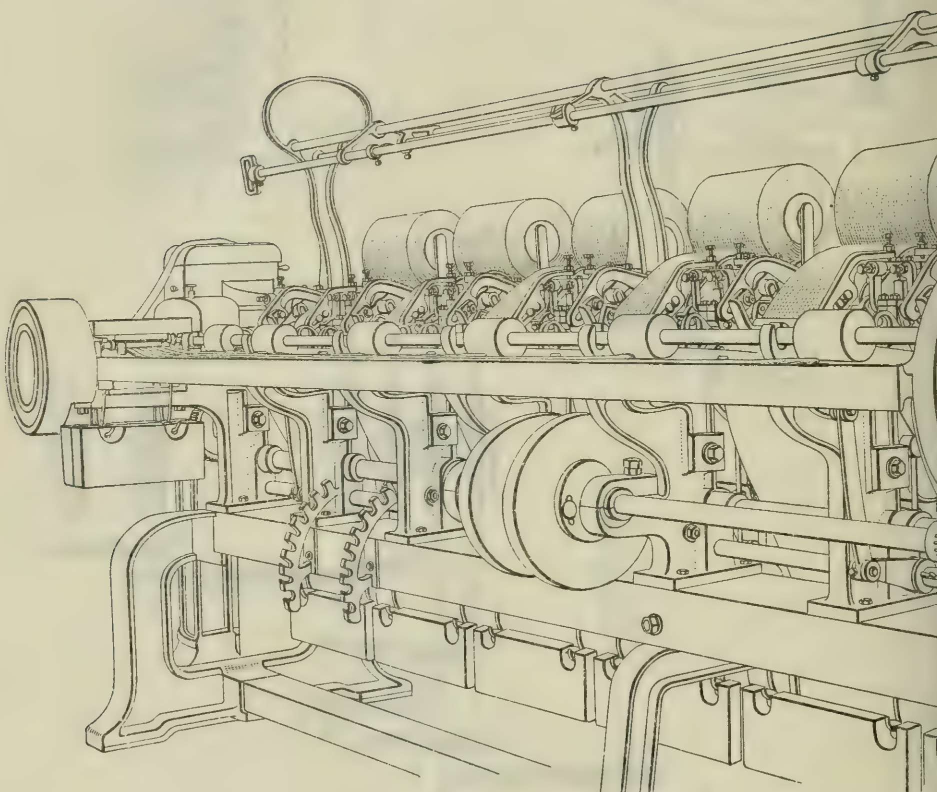
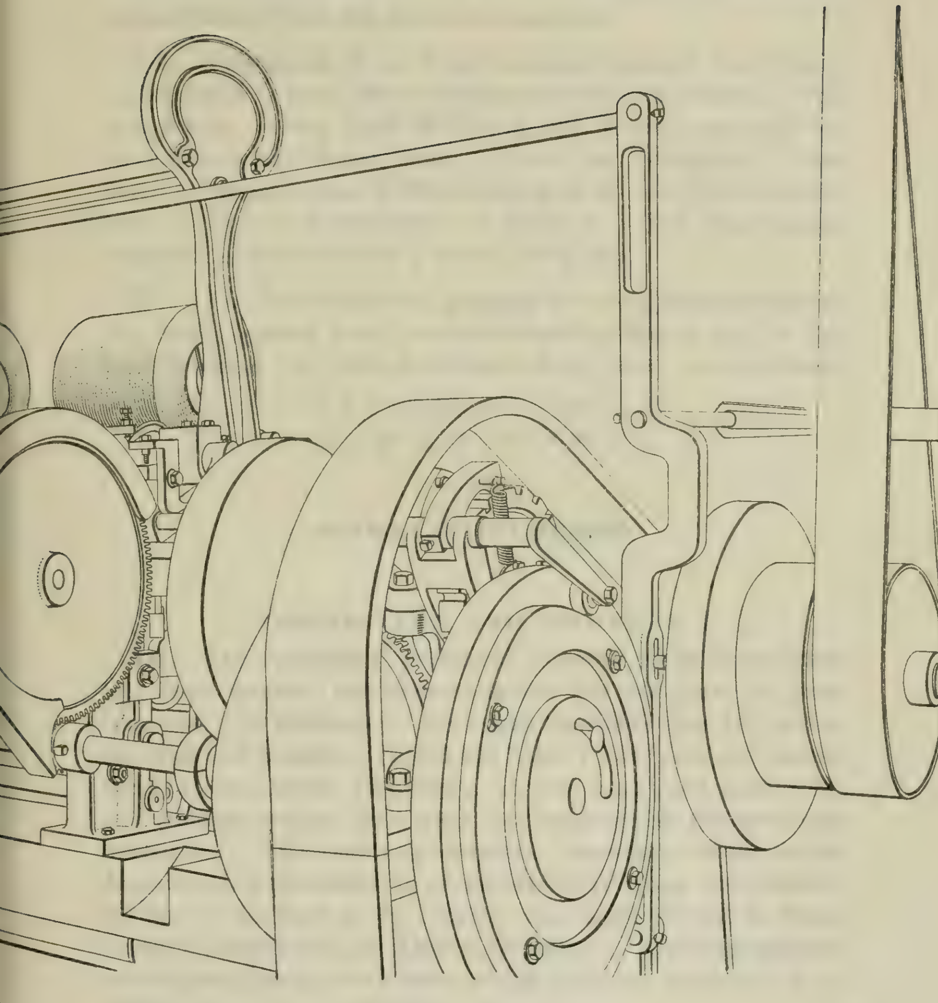

Gearing of Head
Lap Roll 2¾" Dia.
2¾" Dia.
Back Roll 1½" Dia.
1½" Dia.
1⅜" Dia.
1½" Dia.
Front Roll
Driving Shaft
16" Pulley
Calender Roll 3" Dia.
Calender Roll 5" Dia.
Fluted Calender Roll 12" Dia.

FIG. 6





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sheets of the desired width; and the racks and friction motion of the lap head should be set correctly, as mentioned in connection with the sliver-lap machine.

14. The speed of the 5-inch calender rolls of the ribbon-lap machine is from 80 to 110 revolutions per minute. The production varies from 600 to 1,100 pounds per day of 10 hours with 10 per cent. allowed for stoppages. This machine weighs about 4,500 pounds with all weights attached, and requires 1 horsepower to drive it. The floor space required is about 14 feet 2 inches by 4 feet.

15. Fig. 6 is the plan of gearing for a ribbon-lap machine; the draft, figured from the front fluted calender roll to the back drawing roll, with a 50-tooth draft gear, is as follows:

$$\frac{12 \times 30 \times 21 \times 14 \times 20 \times 68 \times 100 \times 70}{30 \times 50 \times 21 \times 40 \times 72 \times 25 \times 50 \times 1\frac{1}{2}} = 5.923$$

SINGLE-NIP COMBER

CONSTRUCTION AND OPERATION

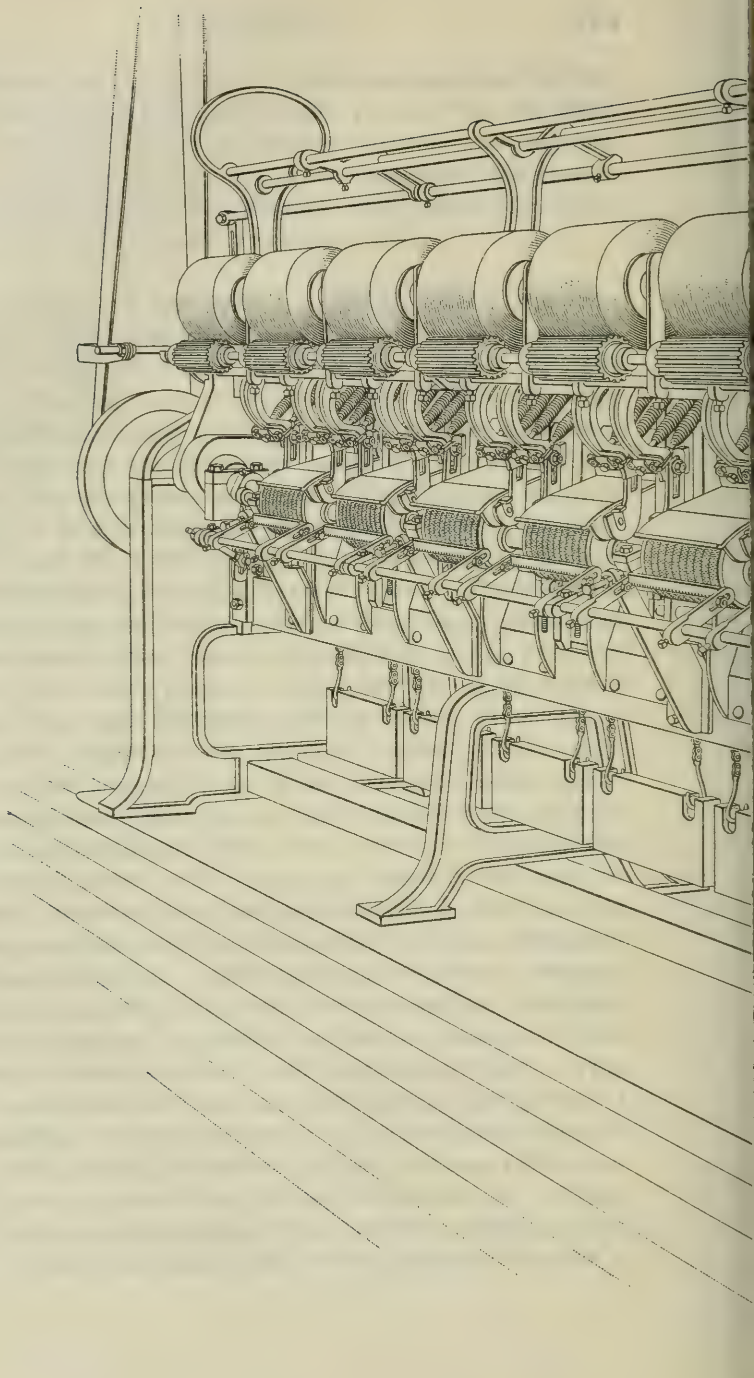
16. The **comber** is employed to select, from cotton that has been carded, the fibers suitable for the class of yarn required. In addition to removing the fibers that are below the standard length, it combs the fibers to be used and makes them lie in parallel positions. It also takes out neps, dirt, and foreign matter that were not removed in the previous processes. The combing machine commonly used, which depends on a combination of somewhat intricate movements for the attainment of its objects, was invented by M. Heilmann, of Mulhouse, in Alsace, Germany. Although numerous improvements have been added by other inventors, it is still spoken of as the Heilmann comber.

A comber is divided into several sections, called **heads**; and as now constructed usually contains six or eight heads, although it may be constructed with a larger or smaller number, as required. Each head is complete in itself and receives

one of the laps delivered by the ribbon-lap machine, but the motions for all the heads derive their power from the same source. While each head is complete in itself, corresponding parts of each head must act at the same time, the results obtained depending on the accuracy with which the corresponding parts of each head work together.

17. Passage of the Stock.—Briefly stated, the laps from the ribbon-lap machine are placed on lap rolls and are fed intermittently by a pair of feed-rolls. When the laps from the ribbon-lap machine are used, they should not weigh more than 300 grains per yard, and when laps are used that come directly from the sliver-lap machine, they should not be heavier than 260 grains per yard. The fringe of cotton is gripped by a pair of nippers, which holds it in such a position that it will be acted on by a cylinder having a portion of its circumference covered with steel points. These points, or needles as they are called, remove short fibers, neps, and foreign substances that were not removed in the previous processes; this waste is then taken from the needles by a revolving brush and ultimately arrives at the waste can.

During this operation, the fringe of cotton that is being combed is entirely separate from the fringe of cotton previously combed, and therefore, in order to have the product delivered in a continuous sliver, it is necessary to detach the newly combed fibers from those not combed, and also to bring back a portion of the cotton previously combed so that it may be pieced up with the fibers that have just undergone the combing operation. After piecing-up has been effected, the cotton just combed is carried forwards and the rear ends of the fibers receive a combing action by means of a top comb, which tends to remove still more short fibers. This cycle of operations is then repeated with a new group of fibers, resulting in the production of a continuous web of combed fibers, which is drawn through a trumpet that condenses it into a sliver and is then delivered on a table, together with similar slivers from the other heads of the comber. From the table the cotton passes through a



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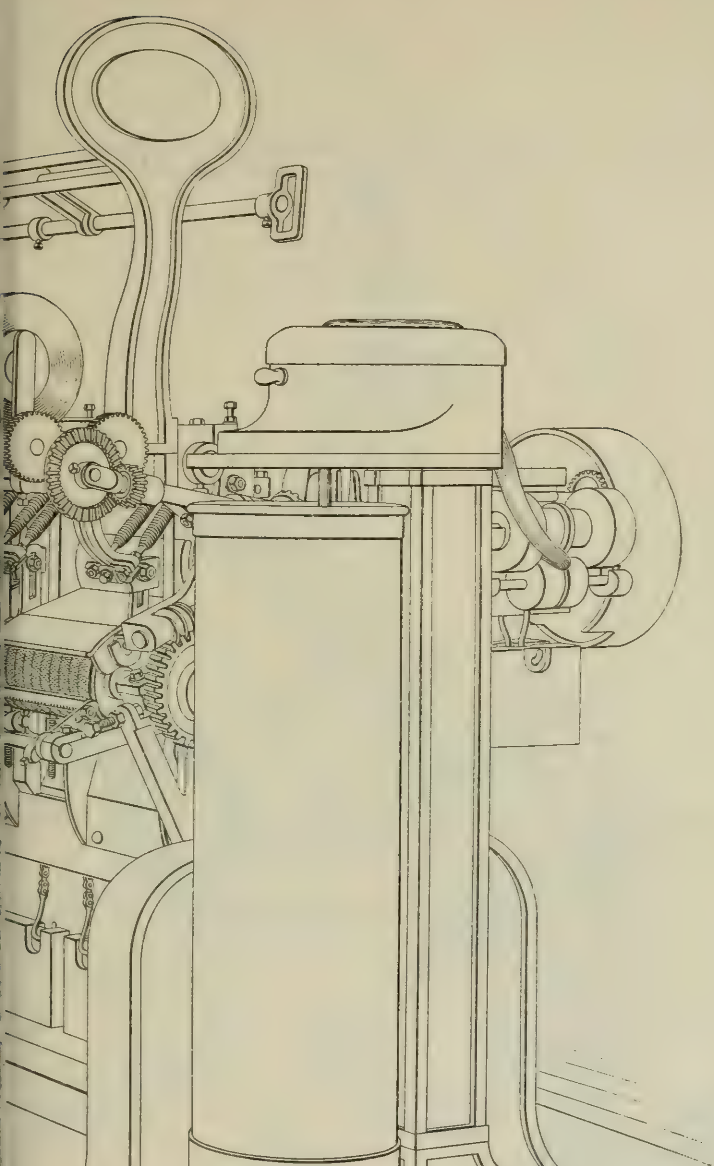

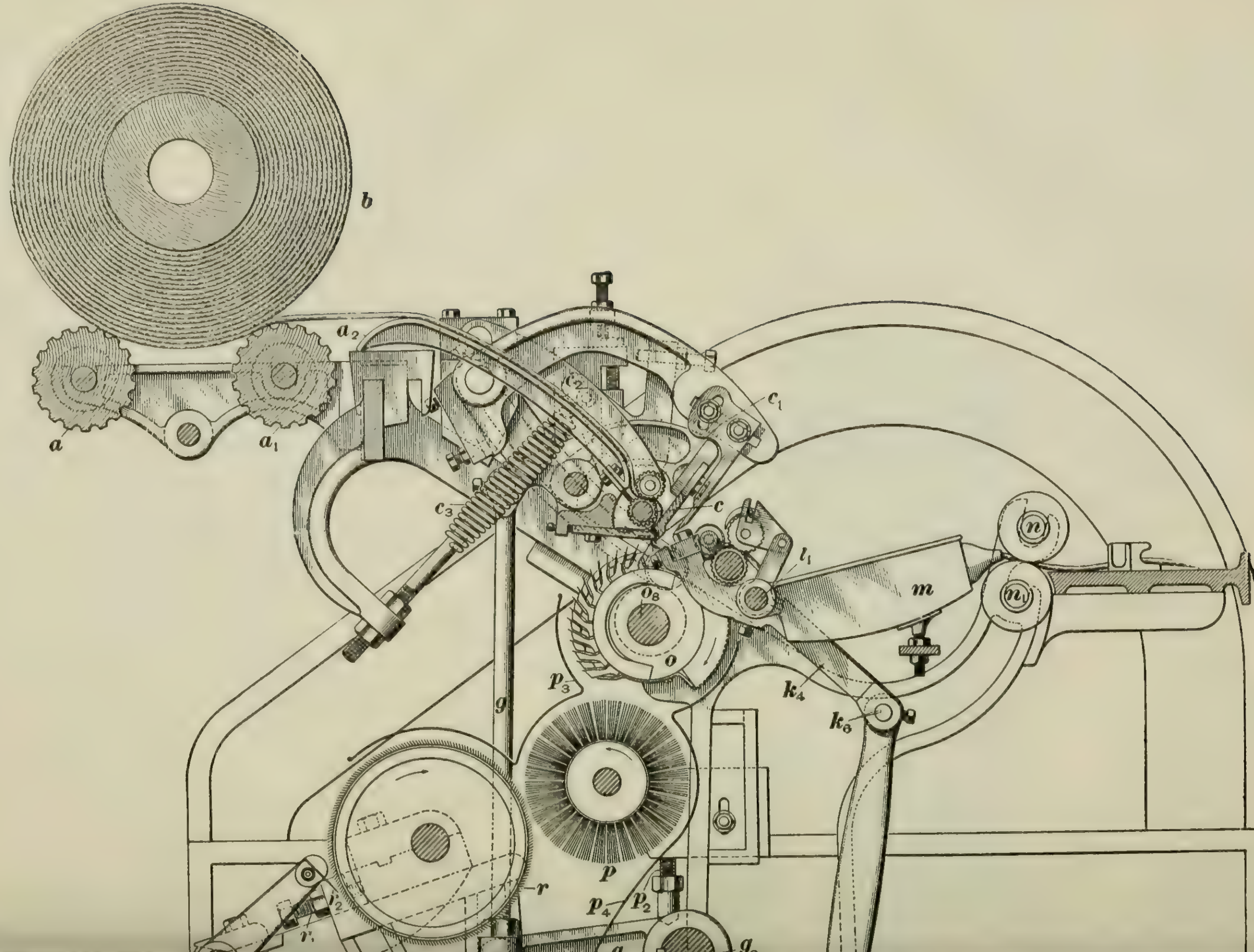

b
a
a1
a2
c2
c1
c3
c
n
n1
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p4
p2
a
g2

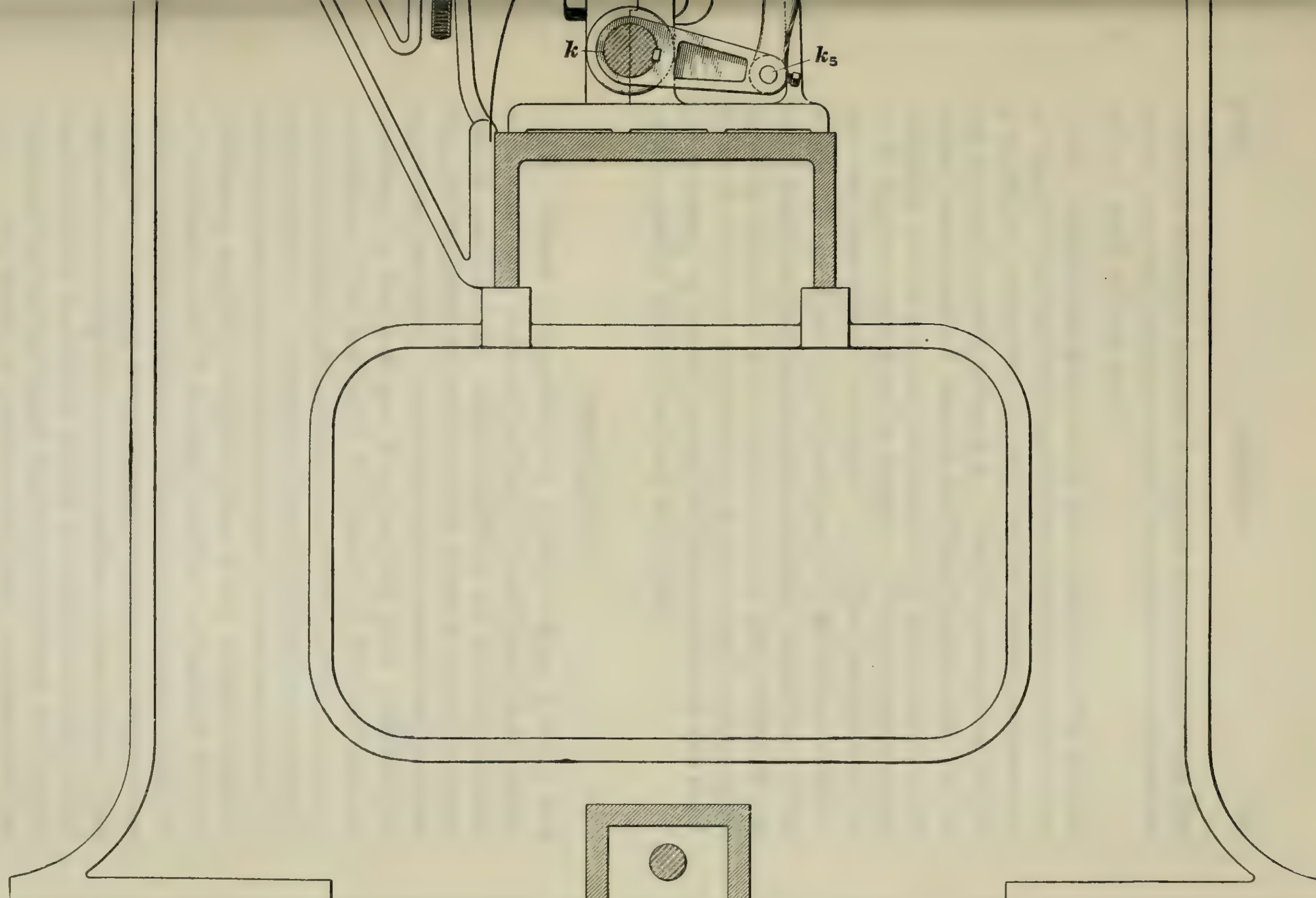


FIG. 9

draw-box and then through a trumpet that condenses all the slivers into one, which is placed in a can by a coiler similar to that used on the card.

18. Principal Motions of the Comber.—The several actions of a comber must necessarily work intermittently, as it would be impossible to run a lap of cotton continuously and to draw a comb through it. For this reason the tuft of cotton being combed must be held firmly at the time of the combing, first at one end and then at the other, and in order to do this, the feed must be stopped. The various motions may be summarized as follows: (1) The feed-motion, by which the lap is fed to the machine; (2) the nipper motion, which holds the cotton during the combing operation; (3) the combing operation by the half lap; (4) the backward and forward motion of the delivery roll, or the piecing-up motion; (5) combing by the top comb; (6) the delivery of the stock to the calender rolls, draw-box, and coiler.

FEED-MOTION

19. Views of a comber are given in Figs. 7 and 8, and a sectional view is shown in Fig. 9. It will also be of advantage in studying the different parts of the comber to make frequent reference to Fig. 27, which shows a plan of the gearing of this machine. In describing the comber it will only be necessary to deal with one head, as each head performs the same work. The lap b, Fig. 9, is placed on the lap rolls a, a_1, and, as it unrolls, the sheet passes over the apron a_2 to a pair of feed-rolls c, c_1. The apron a_2 rests at an angle of about 45° and terminates a little above the nip of the two feed-rolls c, c_1. The apron may be so adjusted that it will assume a greater or less angle, and it is also possible to regulate its distance from the feed-rolls. This apron is usually made of sheet iron, its upper surface being polished or tinned so that there will be as little friction as possible on the cotton. The lower edge of the apron carries a brush, the ends of the bristles of which just touch the bottom feed-roll and keep it clean. This brush is adjustable in such a manner that the

correct contact of the ends of the bristles and the bottom feed-roll may be maintained as the brush wears.

20. Feed-Rolls.—The lower feed-roll c is constructed in one piece and is long enough to serve for all the heads. It is fluted in sections corresponding in number to the number of heads of the comber. Each section, or head, has a top roll c_1, which is slightly longer than the width of each lap. This top roll is made of steel and is fluted to correspond with the flutes of the lower roll. It resembles a

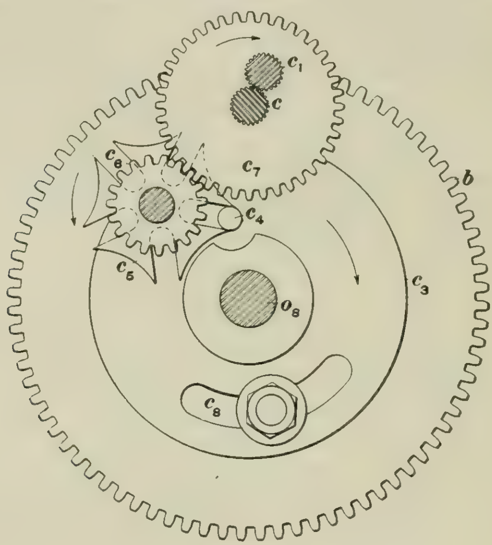


FIG. 10

metallic roll, with the exception that it has no collars; its flutes also have a little finer pitch. It is held in direct contact with the bottom roll by means of an arm c_2 and a spring c_3, as shown in Fig. 9, and receives motion from the lower roll. The lower feed-roll is usually about $\frac{3}{4}$ inch in diameter. The objects of these feed-rolls are: (1) To revolve and deliver a certain length of cotton to the combing mechanism; (2) to stop revolving after the desired length has been delivered and to remain stationary while the combing action takes place.

The method by which the feed-roll receives an intermittent motion is shown in Fig. 10. The feed-roll receives its motion from the cylinder shaft o_8, in the following manner. The gear b is fast to the cylinder shaft and carries a disk plate c_3 from which a pin c_4 projects. A short distance from the center of the cylinder shaft is a stud carrying a star gear c_5. The pin c_4 engaging with the teeth of this star gear turns it during a part of a revolution of the cylinder shaft. The star gear is so constructed that after the pin has engaged with one tooth and turned it, the next tooth will be in position to engage with the pin at the next revolution of o_8. Compounded with the star gear c_5 is a gear c_6 that meshes with a gear c_7 on the lower feed-roll c. Thus, it will be seen that for every revolution of the shaft o_8 the feed-roll is turned a portion of a revolution and the cotton fed to that extent. This intermittent action of the feed-rolls is transmitted to the lap rolls, as the lap rolls are driven from the lower feed-roll.

NIPPERS

21. The fringe of cotton that is fed by this intermittent action of the feed-rolls passes forwards to the mechanism that holds it during the combing process, which is known as the **nippers**. By a combination of levers, the nippers are made to act in such a manner that they open to receive the cotton delivered from the feed-rolls and then close and grip the cotton after it has been passed to them. They again open and release the cotton after it has been combed by the half lap and remain in this position until the next portion of cotton has been delivered to them. The nippers and their attached levers are shown in Fig. 11, reference being made to this figure and also to Fig. 12 in the following description.

22. Cushion Plate.—The nippers are composed of two separate parts, both capable of being moved. The lower part h consists of what is known as the **cushion plate,** Fig. 11. It consists of a flat metal plate slightly longer than the width of the lap. The round nose h_1 of the plate, Fig. 11, is usually covered with a strip of leather

similar to that used for covering rolls, and is fastened by metal strips h_2, h_3. This leather acts as a cushion and prevents the fibers from being injured when pressed against

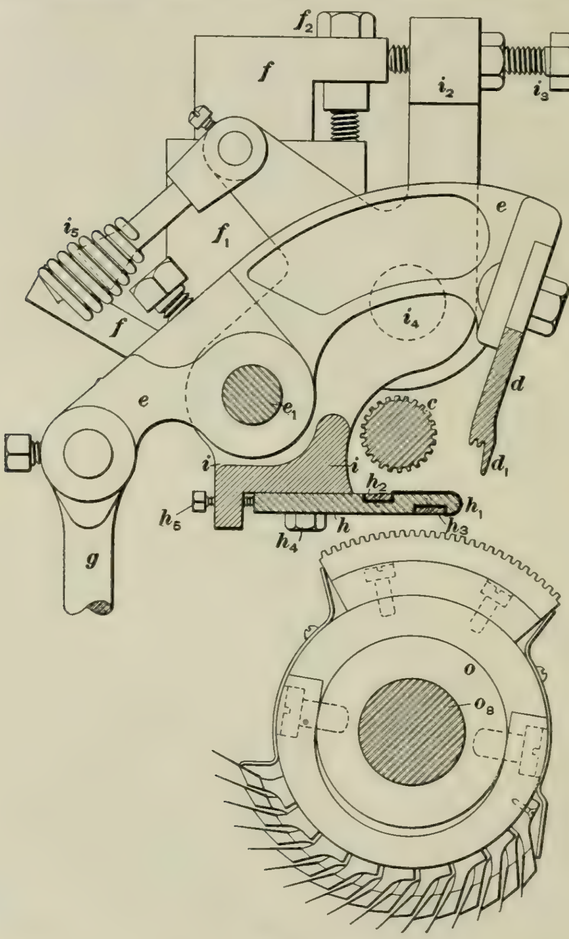


FIG. 11

the plate. The cushion plate is made fast to the frame i by means of three screws, which are inserted on the under side of the plate; one of these screws h_4 is shown in Figs. 11, 12, and 13. In some cases the cushion is applied to the nipper

knife in place of the plate. When this is done a strip of leather about $\frac{3}{16}$ inch thick and $\frac{3}{4}$ inch wide is used, and is fastened to the nipper knife by a strip of steel and small

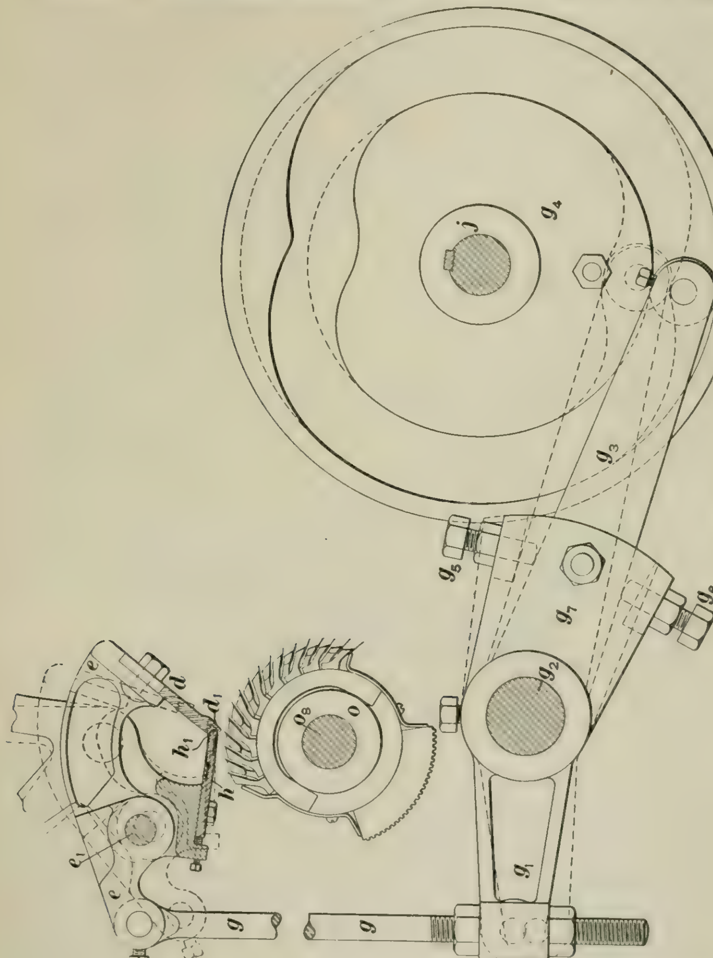


FIG. 12

screws, the lower part of the steel strip acting as the overhanging lip of the nipper knife.

23. Nipper Knife.—The upper part $d\,d_1$, of the nippers in Fig. 11, is known as the **nipper knife**. It consists of a

flat bar of steel; the lower edge is usually fluted and has an overhanging lip d_1. The nipper knife is supported by two arms e, Fig. 11, which are connected to the frame i by the shaft e_1. Two stands and brackets f, f_1, Fig. 11, support the frame i by means of studs i_4. As the cotton must be gripped between the nipper knife d and the cushion plate h, it is evident that these parts must have a movement that will change their position from that shown in Fig. 11. This is accomplished by the movement of the nipper knife.

As shown in Fig. 11, the arms e extend beyond e_1 in the direction opposite to that of the nipper knife. This forms a connection for the rod g, Fig. 12, that is connected to the lever g_1, while this lever is connected to the shaft g_2. Extending from the shaft g_2 is an arm g_3, the end of which carries a cam-bowl that works in the cam-course of the cam g_4 on the shaft j, known as the **cam-shaft.** The shaft g_2 runs the entire length of the heads, and the nipper rods g for each head are connected to it by the method shown. The shaft g_2 receives an oscillating motion from the cam and, in turn, imparts a similar motion to the shaft e_1 of each head. The arms e being connected to this shaft, the nipper knife will rise and fall, its lowest and highest positions being indicated by the full and dotted lines in Fig. 12.

When the nippers receive the cotton, they are in the position shown in Fig. 11, but as soon as the proper amount has been fed, the nipper knife descends, through the action of the cam, and firmly grips the fringe of cotton between itself and the cushion plate, the cushion plate at this point being in the position shown by the dotted lines in Fig. 12. When the knife has securely gripped the fringe of cotton, however, the cushion plate is not in the proper position to allow the cotton to be combed, and it must be lowered so that it will assume the position shown by the full lines in Fig. 12. In order to accomplish this, the knife, which has not reached the full extent of its travel when it comes in contact with the cushion plate, is forced farther down by the cam and carries the cushion plate with it. The cushion plate is capable of being forced down, since it is suspended by the studs i_4,

Fig. 11, which project from the frame i and have bearings on the bracket f_1 connected to the stand f. Thus, the entire frame i can swing on the studs i_4 and cause the cushion plate h to come nearer the cylinder. By this movement the cushion plate and the front lip of the knife are brought close to the needles, thus enabling the cotton to be combed very close to the grip.

As the nipper knife is raised by the action of the cam, the swing frame i is brought back to its original position by means of the springs i_5, Fig. 11. These springs are always

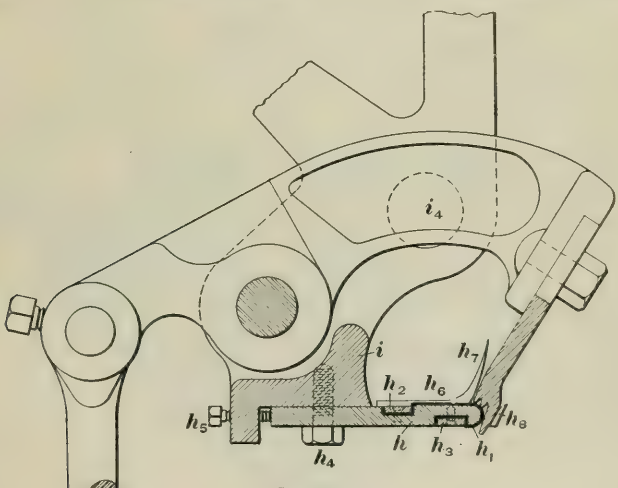


FIG. 13

tending to pull the cushion plate up, but when the knife moves downwards, the tension of the springs is overcome by the positive motion of the knife received from the cam. The position of the cushion plate when the knife is not pressing on it is governed by the distance that the setscrew i_3 projects through the bracket i_2. The setscrew comes in contact with the stand f and prevents the swing frame from moving any farther, but the knife continues to rise and thus the nipper is opened and the fringe of cotton released.

24. As the needles o_7 shown in Fig. 15 pass through the fringe of cotton projecting beyond the nippers, there is a

tendency of the lap to spread, which is also increased by the operation of the feed-rolls. In order to avoid this spreading, a device is used on the cushion plate, a view of which is given in Figs. 13 and 14. It consists of a plate h_6 placed at each end of the cushion plate. These plates carry two projecting pieces h_7, h_8, between which the nipper knife descends, h_7 being curved so that the knife will not come in contact with it. By this means, it is practically impossible for the lap to spread when being combed.

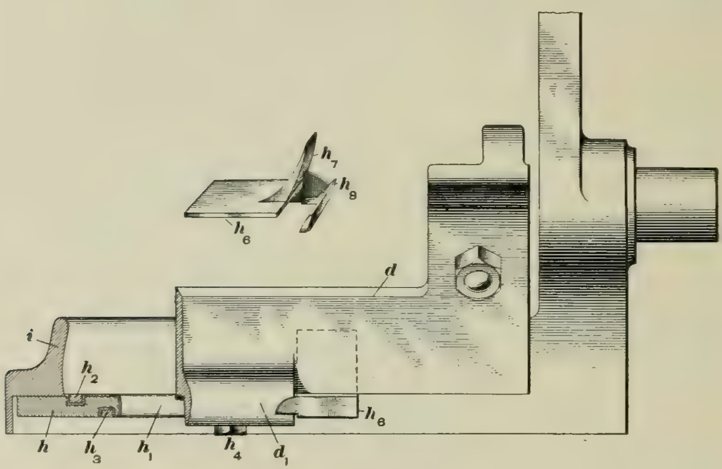


FIG. 14

COMBING OPERATION BY THE HALF LAP

25. Cylinder.—The cylinder consists of three principal parts—the **central stock,** or **barrel,** o_1, Fig. 15, the **half lap** o_2, and the **fluted segment** o_3—the other parts o_4 and o_5 being known as **making-up pieces.** The central stock is secured to the cylinder shaft o_8 by means of screws. The outside of this stock is shaped so as to receive the half lap and the fluted segment, which are secured to it by screws, as shown in Fig. 15. The half lap is composed of two parts—the *comb stock* and the *matrices.* The comb stock is formed to receive a series of matrices, or strips, o_6, to which are fastened seventeen rows of needles o_7 made of round steel tapered to a

point. These needles are so spaced that their number varies from thirty to ninety per inch, while the diameter decreases as the number per inch increases; thus, the needles in the front row of the half lap—that is, those that come in contact with the cotton first—are the most widely spaced, and are also of the largest diameter; the number of needles in the succeeding rows increases, until the finest spacing, that is, the

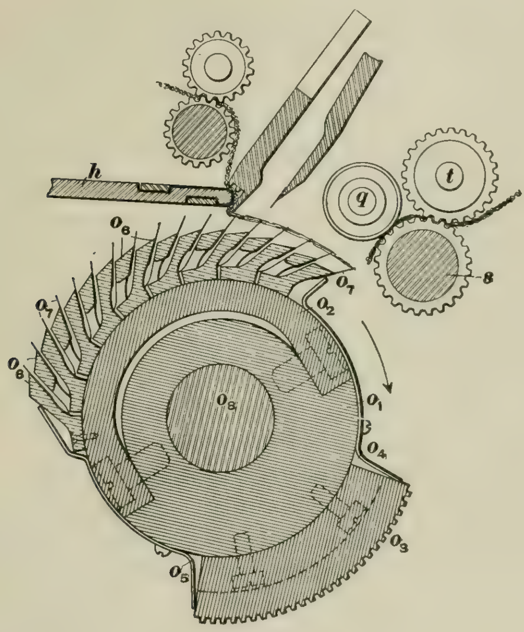


Fig. 15

largest number per inch, occurs in the seventeenth row, in which there are ninety needles per inch, the needles in this row being also of the smallest diameter. For medium work, the number of rows of each number of wire from which the needles are constructed is as follows, commencing with the front row of the half lap and following in the order named: Four rows of 20s, three rows of 22s, two rows of 24s, two rows of 26s, two rows of 28s, three rows of 30s, and one row of 33s. For very fine work, the arrangement of the needles

is sometimes as follows: Six rows of 22s, three rows of 24s, two rows of 26s, two rows of 28s, two rows of 30s, and two rows of 33s.

When setting the needles they are placed in a gauge, point down. The matrix to hold them is placed against the row of large ends while the needles are in the gauge and they are then soldered to the matrix, after which the gauge is removed. The matrices to which the needles are attached are usually made of brass and planed and shaped so as to lie accurately in their proper positions, in order to give the needles the correct angle when they are secured by the setscrews that hold them to the comb stock. By having the half lap constructed in this manner, it is a simple matter to remove it from the machine when a row of needles becomes injured, and then by removing the matrix the damaged needles may be readily replaced. In addition to having the rows of points of the needles in the half lap concentric, each row of needles should be exactly parallel with the cylinder shaft. The width over all of each row of needles is usually a little in excess of the width of the lap, so that the edges of the lap will receive an effective combing.

As the cylinder shaft on which the half lap is mounted is constantly revolving, it will be seen that each fringe of cotton gripped by the nippers will be subjected to the action of the half lap. This action takes place immediately after the cotton has been gripped by the nippers and the cushion plate has been forced down by the nipper knife. The half lap is placed on the cylinder in such a position that the largest and heaviest needles are caused to act first on the fringe of cotton to be combed, in order that they may do the heaviest work and make it easier for the finer needles that follow and give a more effective combing. Any fibers that are not held firmly by the nippers are combed from the fringe of cotton, so that only fibers of sufficient length are left. In addition to these short fibers, dirt and neps are also removed, while the fibers held by the nippers are combed out and laid parallel.

The short fibers and foreign matter that are removed from the fringe are carried by the needles of the half lap until the brush *p*, Fig. 9, removes them and deposits them on the

doffer r, which works at a much slower speed than the brush. The doffer has its surface covered with a clothing, composed usually of leather, having heavy wire teeth inserted in it at an angle. The doffer is not in direct contact with the brush, but as the brush revolves, the centrifugal force throws out the short fibers, and the needles of the doffer are thus enabled to secure them.

26. The Doffer Comb.—As r revolves, the waste is stripped from it by means of a **comb** r_2 that acts on the same principle as the doffer comb of a card. The waste then drops into a can, there usually being one can for two heads. In some cases, however, the waste is wound on a roll. At the back of the cylinder, brush, and part of the doffer there is a tin cover p_3, Fig. 9, which is of a special shape, made in one piece and called the **brush tin.** Another cover, known as the **waste chute,** covers the cylinder and brush on the other side, and is shown at p_4. These covers prevent the escape of waste and also act as a protection against any foreign substance coming in contact with the moving parts.

PIECING-UP MOTION

27. After the cotton has been combed and the nippers opened, the fringe of cotton comes under the action of the **piecing-up motion.** It should be understood that the fringe of cotton being combed is not connected to the cotton previously combed, and in order to have a continuous sliver, each fringe of cotton is pieced up to the cotton immediately in front of it. In order to accomplish this, a portion of the previously combed cotton must be returned, while the fringe must be in a position to be attached to it and carried forwards.

It is the object of the fluted segment, which is a part of the cylinder, to support the fringe of cotton that has just undergone the combing action. The finely fluted surface of the segment is at such a distance from the center of the cylinder shaft that it can come in contact with the under side of the combed fringe and thus support it until it is detached. A view of the segment supporting the fringe is

shown in Fig. 16. When the fringe is held in the position shown, the operation of piecing-up and detaching is performed by three rolls *q*, *s*, *t*; *q* is sometimes termed the *leather detaching roll;* *s*, the *steel detaching roll;* and *t*, the *brass roll.* In other instances *t* is called the *piecing roll.* In this Section, however, *q* will be known as the *leather detaching roll;* *s*, the *delivery roll;* and *t*, the *top roll.* These names are strictly in accordance with the duties and positions of the rolls, as *q* detaches the cotton, and, although *s* assists in this operation, its chief function is to deliver the cotton after it has been detached. The roll *t* also aids in delivering the cotton, and as it is directly above the delivery roll, it may be termed the top roll.

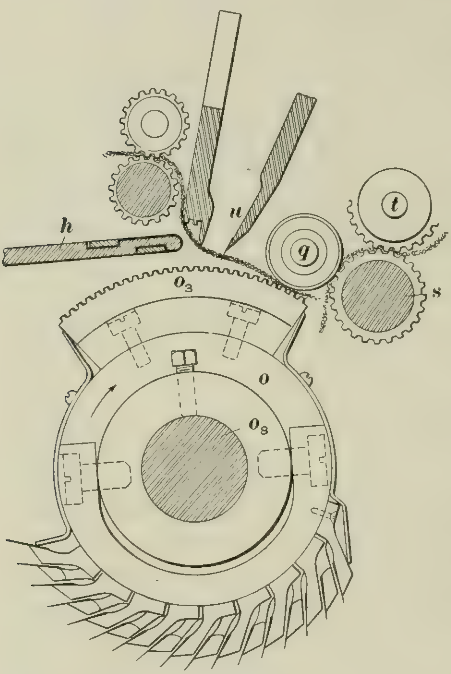


Fig. 16

28. The **delivery roll** *s* is made in one piece long enough to serve for all the heads. Opposite each head is a fluted section, the flutes usually being spaced differently from those of the feed-roll. When a lap $8\frac{1}{2}$ inches in width is used, the fluted section is generally 11 inches wide and contains about fifty flutes for each inch of diameter. The diameter of the roll is usually $\frac{7}{8}$ inch. The roll revolves in bearings on the framework and is in such a position that it is just clear of the needles of the half lap and the segment. The parts of the bearings in contact with the roll are usually made of brass.

29. The **leather detaching roll** q, Fig. 17, is in contact with the delivery roll. The leather portion of the detaching roll is slightly wider than the fluted segment of the

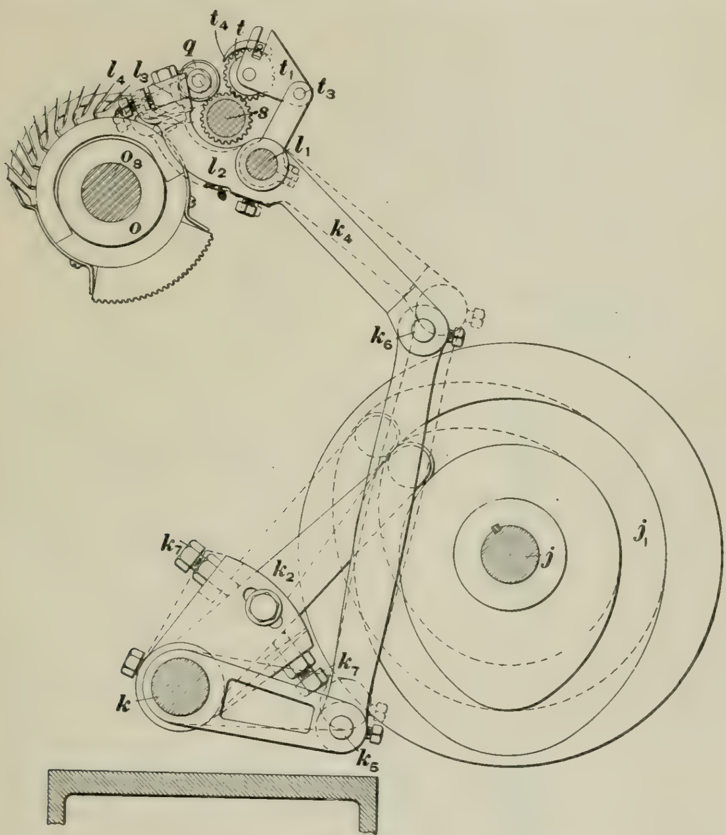


FIG. 17

cylinder and resembles a top roll of the common type, being shown in Fig. 18. The boss of the roll is generally about

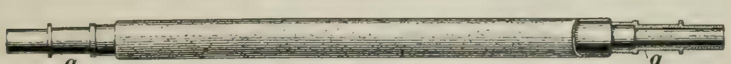


FIG. 18

$10\frac{1}{2}$ inches in length and $\frac{13}{16}$ inch in diameter. The skins used for covering should be of the finest quality, as so few

fibers are dealt with that any irregularity of the roll produces bad work. This roll has brass bushings q_1, Fig. 18, for bearings, which are supported by the blocks l_3, Fig. 17.

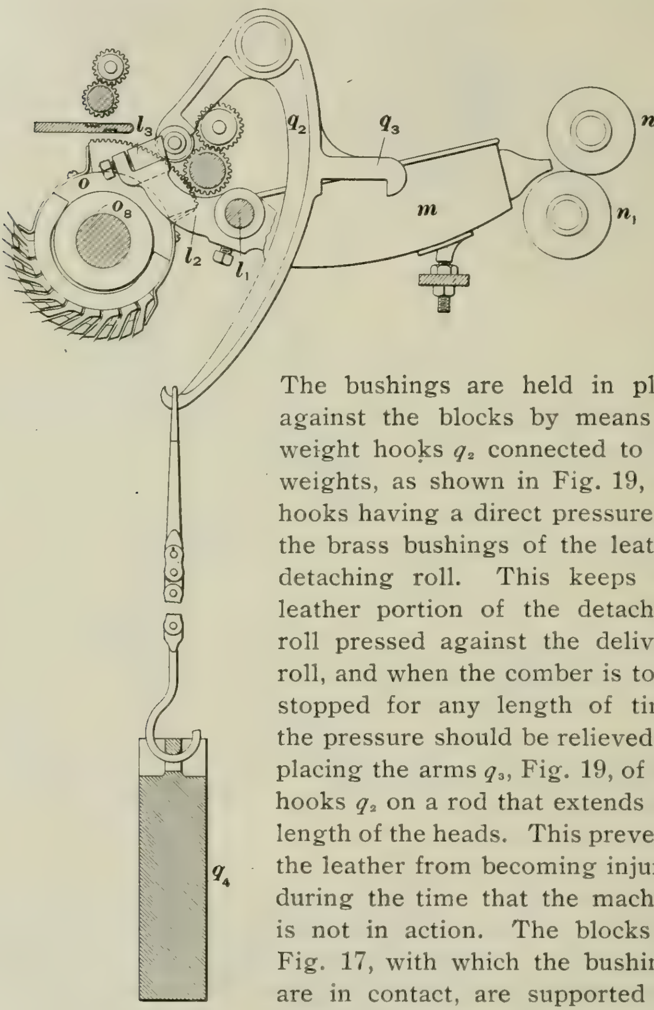


FIG. 19

The bushings are held in place against the blocks by means of weight hooks q_2 connected to the weights, as shown in Fig. 19, the hooks having a direct pressure on the brass bushings of the leather detaching roll. This keeps the leather portion of the detaching roll pressed against the delivery roll, and when the comber is to be stopped for any length of time, the pressure should be relieved by placing the arms q_3, Fig. 19, of the hooks q_2 on a rod that extends the length of the heads. This prevents the leather from becoming injured during the time that the machine is not in action. The blocks l_3, Fig. 17, with which the bushings are in contact, are supported by means of brackets l_2, one of which is shown in this figure. Each head requires two of these brackets, which are fast to the shaft l_1, which is long enough

to serve for two heads and consequently to support four brackets. The shafts have bearings on the framing of the comber and are capable of being moved. The brackets, with their connections, are known as the *horsehead*, or *lifter*.

30. The **top roll** t, Fig. 17, is generally constructed of brass and contains flutes that correspond to the flutes of the delivery roll. The fluted section, however, is usually a little shorter than the fluted section of the delivery roll. This roll is supported by brackets t_1, fast to the shaft l_1, and, as the bearings of the roll are pivoted at t_3, the top roll is always in contact with the delivery roll.

31. Operation of the Rolls.—In order that these rolls may detach the combed cotton from the remainder of the lap, they must be close enough to the fluted segment to secure the cotton at the time of detaching. The position of the rolls when detaching is shown in Fig. 16. By a comparison of this figure with Fig. 15, it is obvious that if, during the combing operation, the detaching roll were in the position that it occupies when detaching, the needles of the half lap would come in contact with the detaching roll. It is therefore necessary that the position of the detaching roll should be alternately changed so that the roll will be near enough to the segment to secure the fibers when detaching and also be out of the path of the needles during the combing action. In order to effect this change in the position of the detaching roll, it is necessary to give the shaft l_1, Fig. 17, which is primarily the support for the roll, a partial revolution. As shown in Fig. 17, there extends from the short shaft l_1 an arm k_4, which, with other connections, serves to connect l_1 with the shaft k. The connection between l_1 and k is jointed at k_5 and k_6; consequently, if k revolves it will turn l_1 without tending to lift it in its bearings. There are three of these connections for a comber of six heads, there being one for each shaft l_1. The shaft k is similar to the shaft g_2 shown in Fig. 12 and extends the entire length of the heads. Fig. 9 shows the relative positions of these shafts.

Extending from the shaft k is an arm k_2, Fig. 17, which carries at its other end a cam-bowl that runs in the course of the lifter, or horsehead, cam j_1. This cam is on the shaft with, and very close to, the nipper cam g_4 shown in Fig. 12. As the cam-shaft j revolves, the shaft k receives an oscillating motion that is transmitted to the shaft l_1 by means of the connections previously described. This motion of l_1 swings the horsehead with l_1 as a center and thus brings the leather detaching roll q in contact with the fluted segment, as shown in Fig. 16. The range of movement of the horsehead is shown by the full and dotted lines in Fig. 17. The full lines show the position of the horsehead and rolls during the combing process, or when the roll is out of the path of the half lap, while the dotted lines show the position of the horsehead and rolls when the detaching roll is in the position it assumes when in operation.

As previously stated, the detaching roll q is supported and its motion governed through being held firmly against the blocks l_3 of the brackets l_2, Fig. 17, by the weights q_4, Fig. 19. When, however, the horsehead is moved back to the limit of its motion, shown by the dotted lines in Fig. 17, the blocks l_3 are so far back that they are not in contact with the brass bushings of the detaching roll. The leather portion of the roll, however, has a bearing directly on the fluted segment, as shown in Fig. 16. As the weights q_4, shown in Fig. 19, are holding the detaching roll against the fluted segment, it is obvious that the fringe of cotton will be effectively gripped between them. The detaching roll is at all times in contact with the delivery roll, around which it moves with the action of the horsehead. As the top roll is connected to the shaft l_1, it also has a movement similar to the detaching roll, and consequently moves around the delivery roll and assumes the position shown in Fig. 16. A clearer t_4, Fig. 17, which is above the top roll and serves to keep it clean, is also supported by the bearings that support the top roll and has a motion similar to this roll.

32. In addition to the rolls being placed in the required positions, they must also have a rotary motion in both

directions in order to carry back a portion of the cotton previously combed, to which the detached portion must be connected in order to deliver the cotton in a continuous line. The mechanism by means of which the delivery roll derives a motion in both directions is shown in Figs. 20, 21, and 22. This motion is also imparted, by means of frictional contact, to the detaching roll and top roll. The mechanism shown in these figures consists of a cam s_1 situated on the cam-shaft j, which also supports the nipper cam and the cam for placing

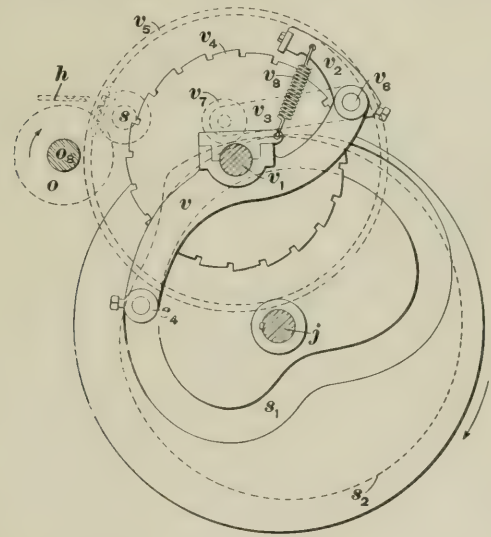


FIG. 20

the detaching roll in position. Running in the cam-course of s_1 is a bowl s_4 fastened at one end of a lever v, the lever being pivoted on a shaft v_1 borne by the frame of the machine. The other end of the lever has a pawl v_2 hinged to it at v_6, which is connected to an auxiliary lever v_3; v_3 also carries a bowl v_7 in contact with a cam s_2, which is in a position adjoining s_1. It will be seen, therefore, that the action of the pawl v_2 will be governed by the two cams s_1, s_2 through the levers v, v_3.

The pawl v_2 is shown as being over the gear v_4. It is held in this position by an arm similar to v situated on the other

side of the gear v_4. This second arm does not have any cam-bowl but, being connected to the other, forms a good support for the pawl v_2 that engages with the teeth of the gear v_4. The construction of the gear v_4 is shown in Fig. 20. This gear is fixed to the shaft v_1, on which v is pivoted. On the same shaft with the gear v_4 is an annular gear v_5 engaging with a gear on the delivery roll s, the relative position of which with the cylinder o is shown in Fig. 20. The backward and forward motions required of the delivery roll must be imparted by the pawl v_2 through the gears v_4, v_6 and the

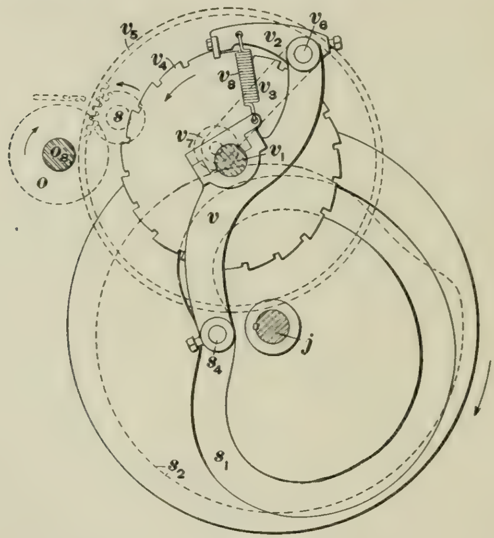


FIG. 21

gear on the delivery roll, the extent of the movement of the delivery roll being governed by the movement of the gear v_4 and the relative number of teeth in the gears by which the delivery roll is driven.

33. The manner in which the pawl acts on the gear v_4 may be seen by reference to Figs. 20, 21, and 22. The pawl v_2 is always tending to be drawn toward the gear v_4 by two springs v_8, only one of which is shown. These springs, however, cannot bring the pawl into connection with the

gear until they are allowed to do so by the cam s_2. As the cam-shaft revolves and the portion of the edge of the cam that is nearest its center comes in contact with the bowl v_7, the pawl hinged at v_6 will be drawn down by the springs until it is in contact with one of the teeth of the gear v_4.

The cam s_1 will also be moving during this time in the direction indicated by the arrow, and the bowl will come in contact with that part of the cam nearest the center. This position is shown in Fig. 21. Changing the position of the

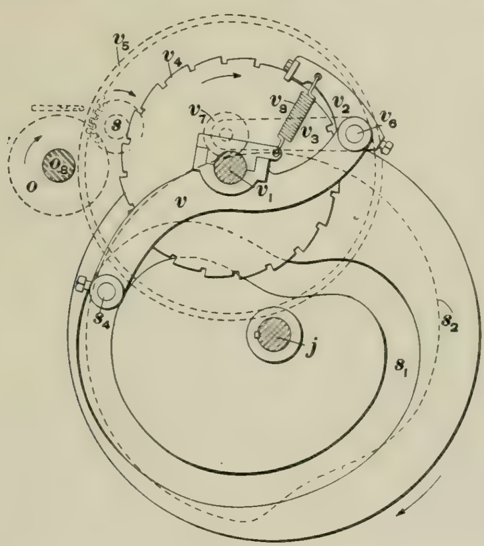


FIG. 22

cam from that shown in Fig. 20 to that shown in Fig. 21 results in moving the gear v_4 in the direction shown by the arrow. The delivery roll s will receive a similar motion and carry back a portion of the cotton previously combed.

The further rotation of the cam s_1 will cause the cam-bowl s_4 to be forced from the center j and this will cause the pawl v_2, and consequently the gear v_4, to move in an opposite direction to that first described. The positions that these parts assume during this motion are shown in Fig. 22. It is therefore evident that the delivery roll will have two motions,

one of which returns a portion of cotton previously combed while the other delivers the cotton that is detached. After the latter movement has taken place, the cam s_2 having moved sufficiently far will remove the pawl from the gear v_4. When the pawl is next allowed to engage with the gear v_4, it will be in such a position that it will drop into the next tooth beyond the one with which it previously engaged.

The delivering movement of the delivery roll is about double its movement in the opposite direction, and the length of cotton actually delivered is dependent on the amount that the former exceeds the latter.

34. The operation of piecing-up may therefore be briefly stated as follows: It is necessary to detach a combed fringe of cotton from a lap and connect it to cotton already combed. The combed fringe of cotton is supported by the fluted segment o_3, as shown in Fig. 16. In order to connect this fringe the cotton immediately in front of it is brought back, by turning the delivery roll in the desired direction, and falls in a space between the half lap and the fluted segment. After the required amount of cotton has been returned, the detaching roll is brought in contact with the fluted segment so that it will grip the cotton to be detached. The delivery roll is then revolved in the opposite direction to that by which it returned the cotton previously combed, and at the same time the detaching roll and the segment detach the cotton from the layer brought forwards by the feed-rolls. During these motions the forward ends of the fibers detached are placed above and upon the rear ends of the fibers that were returned, and thus they are joined together between the detaching roll q and the delivery roll s, after which the detaching roll is moved out of the path of the half lap so that it will not interfere with the operation of combing the next tuft of cotton held by the nippers.

COMBING BY THE TOP COMB

35. Another operation performed in connection with that of detaching is the combing of that portion of the fibers held by the nippers when the half lap is in action and

which, consequently, cannot be combed by the half lap. This portion of cotton is combed by the action of the top comb shown at the lower end of the plate u, Fig. 23. This comb is constructed with one or two rows of needles soldered to the plate, it being claimed on the one hand that two rows of needles give a more effective combing, while on the other hand it is stated that dirt collects between the two rows of needles and afterwards drops back into the cotton. Another disadvantage of two rows of needles is that they are more liable to come in contact with some of the moving parts during the operation of piecing-up because of the small space between the nippers and the detaching roll. It is also more difficult to straighten the needles if they become bent or hooked than when a single row is used. When made with two rows, there is usually a coarse row with 30 teeth per inch and a finer row with 60 teeth per inch.

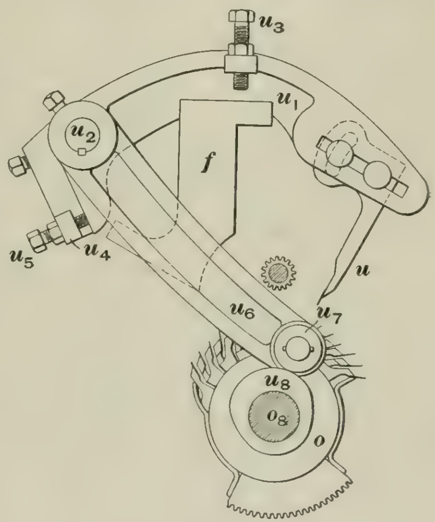


FIG. 23

The plate, or blade, to which the needles are soldered is supported by brackets u_1, Fig. 23, there being two for each comb, or head. These brackets are connected to the shaft u_2, which extends the length of the heads and supports the brackets for each head. At one end of this shaft is a lever u_6 carrying a cam-bowl u_7, which is in contact with the cam u_8 on the cylinder shaft o_8. As the cylinder shaft revolves, the top comb will be alternately raised and lowered by the action of the cam. The comb is given this movement because when the half lap is combing, as shown in Fig. 15, the top comb must be up out of the way so that it will not

interfere with the action of the half lap. The top comb is lowered immediately after the half lap has passed and before the operation of detaching takes place. It is shown almost in position in Fig. 24, where the half lap has just passed; while in Fig. 16 it is shown in its combing position. As the fibers are detached by the detaching roll and segment the top comb is in its lowest position and the fibers that were held by the nippers are drawn through the comb by the detaching roll and segment; in this manner dirt and any

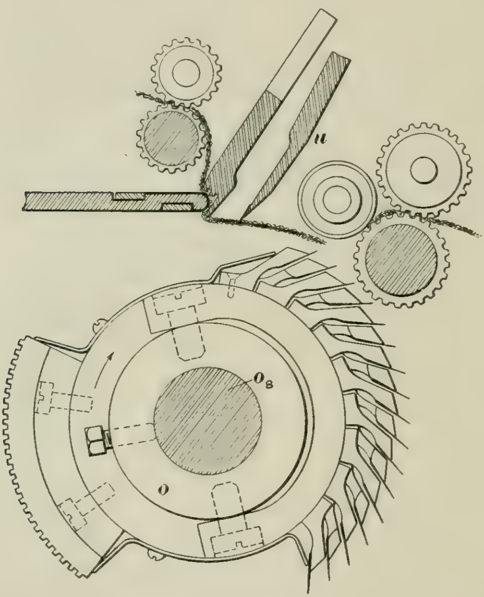


FIG. 24

fibers too short to be held by the segment and detaching roll are removed, after which the comb is raised so that it will not interfere with the action of the half lap. The matter combed out by the top comb that is not retained by the fringe projecting from the feed-rolls drops into the space on the cylinder between the fluted segment and the half lap. The matter retained by the fringe is removed by the half lap during its next combing operation.

DELIVERY OF THE STOCK

36. Calender Rolls.—The cotton when freed from the action of the top roll and delivery roll is delivered into a pan made of tin and shaped somewhat like a right triangle with its base adjoining the delivery roll. A side view of one of these pans is shown at m, Fig. 9. Each pan is from about $1\frac{1}{2}$ inches to 2 inches deep, its bottom being perforated so that any foreign substances that fall from the cotton will pass out of the pan and thus be prevented from entering the cotton again. At the end of the pan farthest from the delivery roll is a trumpet, as shown in Fig. 9, which has its larger end in the pan. The cotton when delivered in the pan is in the form of a transparent web nearly as wide as the leather portion of the detaching roll. It is drawn through the trumpet by the table calender rolls, which are shown at n and n_1, Fig. 9. By this means the web is condensed into the form of a sliver and delivered on a table, as shown in Fig. 25.

37. The **table** and the **table calender rolls** for a comber of six heads are shown in Fig. 25. The lower calender rolls are on a shaft that extends the length of the heads, while the upper ones, which are self-weighted, receive motion by frictional contact with the lower rolls. These rolls revolve continually at the required speed to take up the excess amount of cotton delivered by the delivery roll over that carried back for piecing-up, or in other words, the net amount delivered by the delivery roll. As these rolls are revolving continually in one direction, and as the delivery roll sometimes moves in the same direction and at other times in an opposite direction, the web of cotton in the pan is alternately slack and tight, which gives a wavy motion to the web. The web at any time should not be so slack that it will fall to the bottom of the pan, nor should it be so tight that it will be strained.

The table on which the slivers are delivered is about 7 inches wide. Its surface is polished in order to present the least possible resistance to the slivers as they pass over it. Guides are placed on this table at various distances from

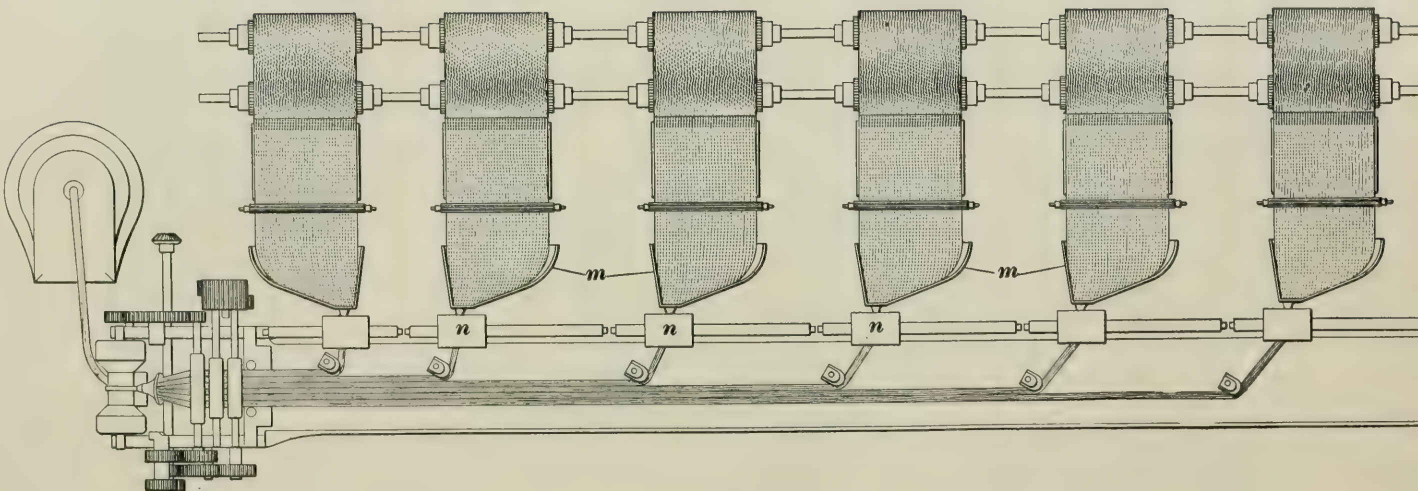


FIG. 25

the calender rolls so that the different slivers will be guided on the table and lie in a position side by side instead of crowding on one another. In this manner, the slivers are drawn along the table by the back rolls of a set situated in the draw-box shown in Fig. 25.

38. The Draw-Box.—Up to this point each lap and the sliver formed from each lap is treated individually. All the slivers are, however, drawn into the **draw-box** together. The draw-box has three pair of rolls, which may be either of the common or metallic types, and these rolls give to the sliver a slight draft, although the principal draft of a comber is between the feed-rolls and the table calender rolls.

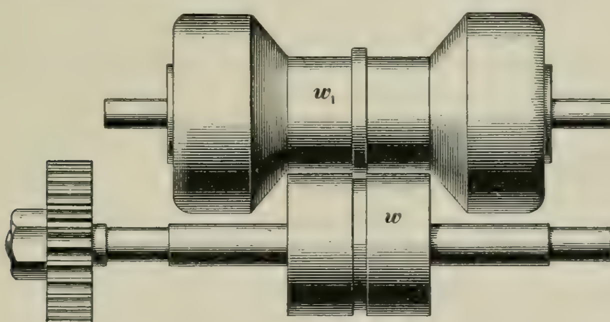


FIG. 26

39. The slivers after being subjected to the draft of the drawing rolls are drawn through a trumpet by a pair of calender rolls and are thus condensed into one sliver. The calender rolls that draw the slivers through the trumpet are different in construction from most calender rolls; they are shown in Fig. 26. The bottom roll w has a groove into which the small end of the trumpet projects, while the top roll w_1, which is driven by frictional contact, has a collar that fits into the groove of the bottom roll. As the sliver runs in the groove of the lower roll it will be effectively condensed by the top roll, which is self-weighted.

From these calender rolls the sliver passes to a coiler, which is similar to the coilers described in connection with other machines.

SUMMARY

40. As the operation of a comber is somewhat complicated, which is due to the many different mechanisms that are brought into action, a short summary will be given here, as an aid to the understanding of the operations as a whole.

In order to bring the cotton into a position to be combed, it is first necessary that a certain length should be delivered by the feed-rolls. After the cotton has been fed by these rolls, the nipper knife descends and not only grips it firmly but also, by depressing the cushion plate, brings the fringe of cotton into a suitable position to be acted on by the needles of the half lap. The cylinder is in such a position that, when the nipper knife has completed its downward motion, the first row of needles on the half lap enters the end of the fringe of cotton, and, as the cylinder revolves, the successive rows of needles remove all the fibers that are too short to be retained by the nippers, as well as the neps that have been left in the cotton. After the needles on the half lap have passed the fringe of cotton, the ends of the fibers fall into the gap left between the needles and the segment, and the nipper knife, together with the cushion plate, begins to rise. When the cushion plate has reached its uppermost position, the further lifting of the nipper knife releases the fibers at this point. During this operation the portion of the cotton previously combed has been brought back and is now ready to be pieced up with the cotton that has just undergone the combing operation by the half lap.

The cylinder having revolved until the fluted segment is in the desired position, the detaching roll descends and grips the cotton firmly between itself and the fluted segment. The further revolving of the fluted segment, together with the detaching roll, draws away the fibers that are not held by the grip of the feed-rolls, and since the top comb has by this time dropped into such a position that it protrudes into the end of the lap just in advance of the portion that has not been cleaned by the needles of the half lap, it efficiently combs this portion of the fibers. At the beginning of this

operation the forward ends of the fibers being combed are carried forwards sufficiently to overlap the rear ends of the fibers that were returned; consequently, the forward rotation of the delivery roll, which occurs while the detaching roll is in contact with the segment, assists in piecing up the fibers just detached to those previously combed, and delivers them into the pan.

It should be clearly understood at this point that all the fibers do not project from the feed-rolls to the same extent at one time. For example, some of the fibers may not be gripped by the feed-rolls at all, while other fibers may project beyond the feed-rolls a quarter of their length, some half of their length, and some three-quarters of their length; consequently, when the detaching action takes place, only those fibers that project entirely beyond the feed-rolls are gripped and drawn forwards by the action of the detaching roll and fluted segment, while those fibers that project only partly beyond and are still gripped by the feed-rolls form a fringe of cotton that is always present in front of the feed-rolls. At the next delivery of the feed-rolls those fibers that previously projected only partly beyond the rolls may now project entirely beyond the rolls, and consequently at the next detaching operation these fibers will be drawn forwards in a manner similar to those previously detached.

From the delivery roll, the cotton passes into the pan, through the trumpet, between the table calender rolls, and is delivered on to the table, along which it is drawn together with the other slivers that have been delivered by the various heads. From the table the slivers pass to the draw-box, where they are given a slight draft, after which they pass through a trumpet and between a pair of calender rolls, where they are condensed into one sliver. From the calender rolls the sliver passes to the coiler and then to the can.

GEARING

41. A plan of the gearing of a comber is shown in Fig. 27, and from this figure the manner in which the various mechanisms receive their motions may be seen. The

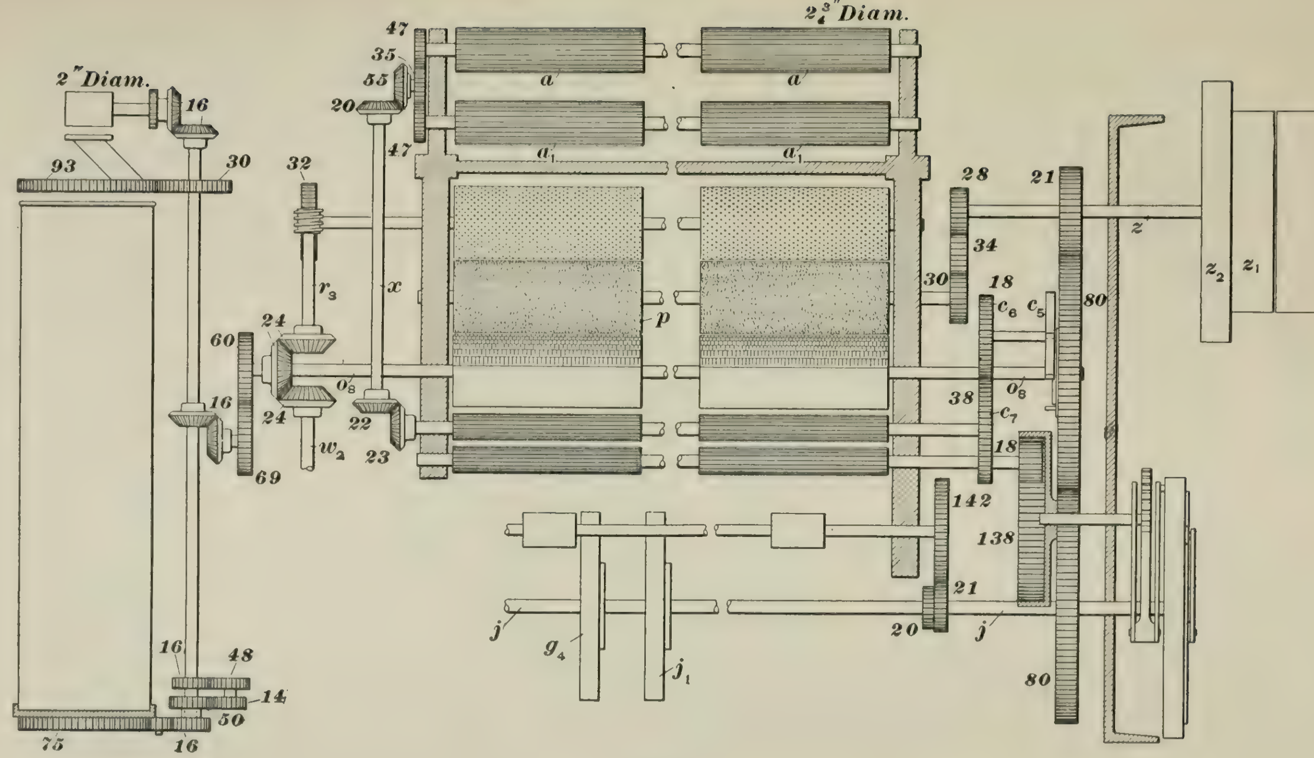
pulley z_1 is driven from the shafting of the room. This pulley is firmly keyed to the short shaft z, which is carried by the framing and steadied in its motion by the balance wheel z_2 in order to prevent a variation of speed, which might be caused by the intermittent actions of some of the parts of the comber.

On the shaft z is fixed a pinion of 21 teeth, which drives a gear of 80 teeth on the cylinder shaft o_8. Meshing with the gear of 80 teeth on the cylinder shaft is a gear of 80 teeth on the cam-shaft j; consequently, the cam-shaft and cylinder shaft revolve at the same speed. On the cam-shaft, the positions of the various cams are shown, these being the nipper cam g_4, the cam j_1 for placing the detaching roll in its required position, and the cams s_1, s_2, Fig. 20, these two latter cams being situated at the extreme right of the cam-shaft in Fig. 27. The shaft supporting the lower table calender rolls is driven from the cam-shaft as shown.

Combers were first constructed with a short cam-shaft, and the cams were placed nearer the driving end of the machine. The connections to the shafts from which the nippers receive motion and from which the detaching roll is placed in position were at one end of these shafts. When constructed in this manner, the torsion on the shafts was such that the parts for each head that received motion from these shafts did not work simultaneously. The first remedy was to make the shafts larger, but later the combers were constructed with the nipper and lifter cams in the center of the comber, so that the connection was made to the centers of the shafts that they operated.

The disk containing the pin from which the feed-roll receives motion, as shown in Fig. 10, is attached to the gear of 80 teeth on the cylinder shaft. The star gear c_5 of 5 teeth, shown in Fig. 27, is on a short shaft, the other end of which carries the draft change gear c_6, which drives a gear c_7 on the feed-roll. At the other end of the feed-roll is a gear that, by means of the shaft x, drives the lap rolls a, a_1.

The brush p, which cleans the needles of the half lap used in the combing process, is driven from the shaft z through



2" Diam.
16
93
30
32
47
35
55
20
47
$2\frac{3}{4}$" Diam.
a
a
a_1
a_1
r_3
x
p
24
60
24
16
o_8
22
23
w_2
69
28
21
34
z
z_2
z_1
30
18
c_6
c_5
80
38
o_8
c_7
18
142
138
21
20
j
j
g_4
j_1
80
16
48
14
50
75
16

Fig. 27

a carrier gear, change gears being provided for driving the brush shaft at different speeds. The cylinder shaft at its end opposite to that of the gear of 80 teeth has a gear that drives the doffer by means of the shaft r_3, and also the drawing rolls of the draw-box and the calender rolls by means of the shaft w_2. From this end of the cylinder shaft, the coiler is driven by the gear of 60 teeth, change gears being provided so that the speed of the coiler may be altered in order to have the coiler properly take up the sliver. The comb for removing the waste from the doffer is not shown in the figure, but it is driven by a simple crank-motion, the stud that turns the crank being at the extreme inner end of the shaft z.

42. The draft for the gearing shown in Fig. 27, with an 18-tooth draft change gear, figuring from the 2-inch coiler calender roll to the $2\frac{3}{4}$-inch lap roll at the back of the comber, is as follows:

$$\frac{2 \times 16 \times 16 \times 60 \times 5 \times 38 \times 22 \times 55 \times 47}{16 \times 16 \times 69 \times 1 \times 18 \times 23 \times 20 \times 35 \times 2\frac{3}{4}} = 23.579$$

As the comber removes a very large percentage of waste from the cotton that passes through it, it is not possible to figure accurately the weight of the sliver produced by simply taking into consideration the weight per yard of the lap fed in, the number of doublings, and the draft of the machine. An example will make this point clearer.

Example.—Suppose that a comber with a draft of 23.579 has six laps up at the back, each lap weighing 260 grains per yard, and it is desired to find the weight per yard of the sliver delivered.

Solution.—Multiplying the weight per yard of the laps fed in by the number of laps, and dividing by the draft gives 66.1605 grains as the weight per yard of the sliver delivered; $\frac{260 \times 6}{23.579} = 66.1605$. If 20 per cent. of the cotton that passes through the machine is taken out as waste, the result obtained above must be diminished by 20 per cent., in order to obtain the actual weight per yard of the sliver delivered; 20 per cent. of 66.1605 is 13.2321, which deducted from 66.1605 gives 52.9284 as the grains per yard of the sliver produced. Ans.

VARIATIONS IN CONSTRUCTION

43. Quadrant Motion.—A different mechanism for imparting the rotary motions to the delivery roll is shown in

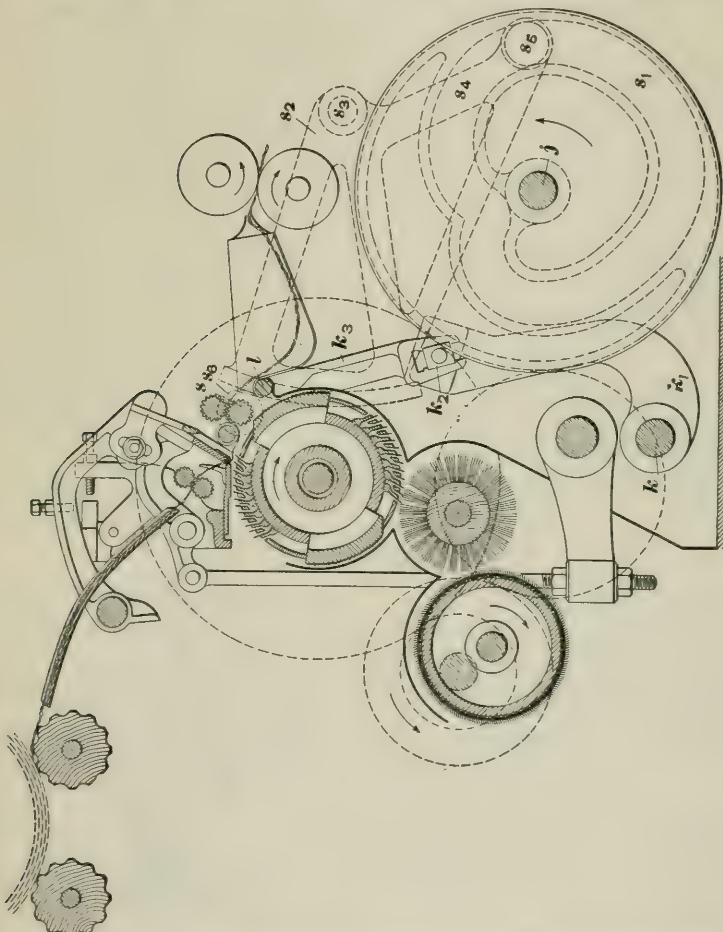


FIG. 28

Figs. 28, 29, and 30, and is applied to combers that have their other parts constructed in a manner similar to those described.

This mechanism consists of a cam s_1 known as the *quadrant cam*, which is fast on the cam-shaft j. Working in

the cam-course is a bowl s_5 that is supported by the lever s_2 centered at s_3. The other end of this lever contains teeth, and it is from the shape of the lever that the name quadrant is derived. The toothed portion s_4, Fig. 30, of the lever s_2 connects with a gear s_6 loose on the delivery roll s. At one end of the gear s_6 is one part of a clutch that, when brought in contact with the other part s_7 that is fast to the delivery roll s, will impart any motion of the gear s_6 to the delivery roll. The cam v_1, Fig. 30, which is also on the cam-shaft, by means of the lever v_2 that is centered at v_3, moves the part of the clutch that is loose on the delivery roll into, and out of, contact with the other part. It will be seen that with this construction the delivery roll will receive motion from the cam s_1 during the time that the parts of the clutch are held in contact by the cam v_1. When in action, the clutch is first connected by means of the cam v_1 acting on the lever v_2, Fig. 30, the clutch corresponding to the pawl v_2 in the mechanism previously described.

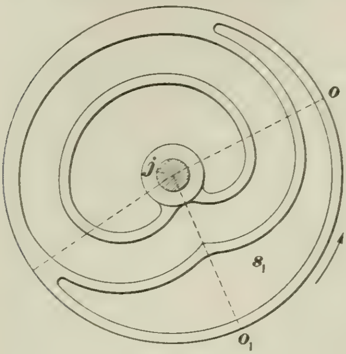


FIG. 29

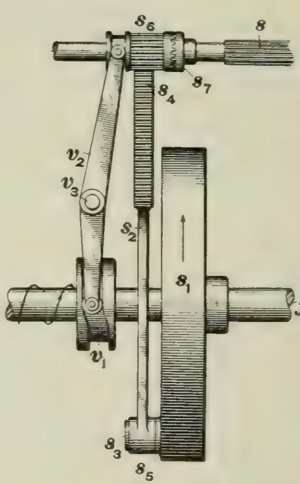


FIG. 30

The delivery roll then begins to turn back as the bowl of the cam s_1 leaves the line o, Fig. 29, and approaches the line o_1. At the line o_1, the cam-bowl commences to move from the center of the cam-shaft, thus reversing the motion of the delivery roll. This reverse motion ceases when the clutch is disconnected by means of

the cam v_1, Fig. 30, which occurs at the time that the cam-bowl s_6 is about to enter that part of the cam-course that is nearly concentric with the cam-shaft. The points at which the clutch is connected and disconnected will govern the character of the piecing in the same manner as the action of the pawl described in connection with Figs. 20, 21, and 22.

44. Another method of lifting the leather detaching roll is shown in Fig. 28. On the lifter shaft k is an arm k_1 that carries a stud on which works loosely a square block k_2; on the shaft l is an arm k_3, on the lower end of which is a cut-out into which the square block k_2 fits. As the arm k_1 is moved by the action of the lifter cam, it, in turn, moves the arm k_3 and shaft l and so lifts and lowers the leather detaching rolls. One point of improvement claimed for this method is that there is less lost motion; and therefore a more accurate setting of the leather detaching roll is obtained.

Another method of lifting the leather detaching roll is to connect the shafts l directly to the lifter cams, using a separate cam for each shaft, which usually operates the rolls for two heads.

DOUBLE-NIP COMBER

45. Purpose.—In order to obtain a greater production than is obtained with a comber constructed as previously described, machines known as **double-nip combers** are built. These combers act on two portions of cotton during each revolution of the cylinder, whereas in a single-nip comber only one portion of cotton is treated for every revolution of the cylinder.

46. Construction.—The cylinder of a double-nip comber contains two half laps and two fluted segments, but the half laps have only thirteen rows of needles in place of the seventeen of the single-nip comber, since two half laps of seventeen rows each would occupy too much space. The segments are also made correspondingly narrower. The segments and the half laps are arranged alternately on the cylinder with slight spaces between them, in order that the cotton

may assume the positions shown in Fig. 16 and thus be properly pieced up. A sectional view of a double-nip comber equipped with a clutch and quadrant is shown in Fig. 28.

In order that a portion of cotton shall be presented to each half lap, or that the feed-rolls shall receive motion twice for every revolution of the cylinder, another pin is placed on the disk plate, shown in Fig. 10, in such a position that the two pins will be exactly opposite each other. The other intermittent motions of the machine must therefore have two movements for each revolution of the cylinder shaft; this is provided for by having the gearing arranged in such a manner that the cam-shaft receives two revolutions for every revolution of the cylinder shaft, thus causing the parts that receive their movement from the cams on the cam-shaft to perform their work twice during this time.

47. A comber with a double nip gives a greater production than a comber with a single nip, but does not, however, clean the cotton so well, because of the smaller number of needles acting on the fringe. Another disadvantage of the double-nip comber as compared with the single-nip comber is due to some of the parts running at such a high speed that they not only wear out more quickly but easily get away from their proper settings and timings, thus producing bad work.

COMBERS

(PART 2)

SETTING AND TIMING

INTRODUCTION

1. Aside from the general construction of a comber, two subjects closely related to the machine and very important to the success of the combing process that should be considered in this connection are *setting* and *timing*. The **setting** of a comber implies regulating the distance between its working parts by gauges. **Timing** is a process that has arisen from the fact that a comber is intermittent in its action and that it is therefore necessary to time the motions of its various parts so that they will be performing their work when some working part that is taken as a basis for timing is performing a certain operation.

Although the range within which these settings and timings can be regulated and worked successfully is very limited, it is very seldom that two persons in charge of combers will agree on these questions. The principal points to be taken into consideration, however, are the length of the staple of the cotton to be used, the weight of the lap fed, the kind of cotton used, the quality of the work required, and, as a consequence of the last, the amount of waste to be combed out.

It is obvious that a different combination of settings and timings will be required when cotton with $1\frac{1}{4}$-inch staple is being used than when the cotton has a $1\frac{3}{4}$-inch staple. This is also true in connection with medium or low grades of combed yarn as compared with fine yarns, since it is not necessary to take out so much waste in the former case.

SETTING

2. Gauges.—The several kinds of gauges used in setting a comber are shown in Fig. 1, and include the regular comber gauge (*a*), the step gauge (*b*), the finger gauge (*c*), the quadrant gauge (*d*), the cradle gauge (*e*), and brush gauge (*f*).

1. *Comber Gauge.*—There are several gauges similar to *a*, the blades of which vary from No. 12 to No. 28 in thickness. They are numbered according to a wire gauge and decrease in thickness as the numbers increase, a No. 20

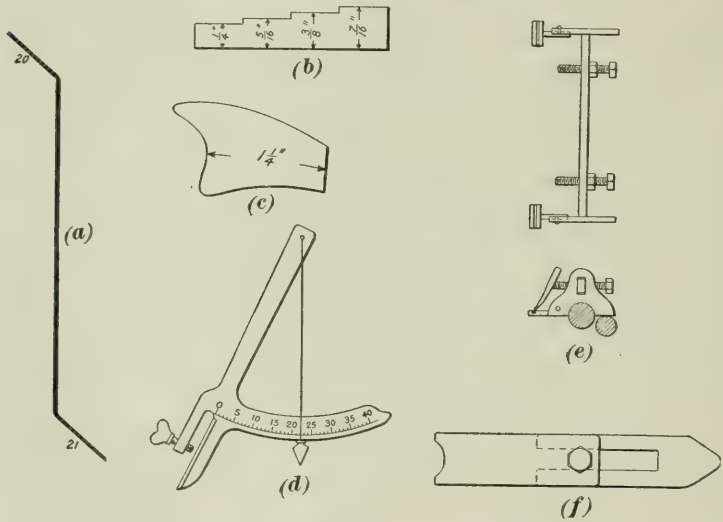


Fig. 1

meaning that the gauge is equal in thickness to a No. 20 wire. These gauges are about $\frac{5}{8}$ inch wide, and usually about $4\frac{1}{2}$ inches long. Each really consists of two gauges, one at each end; for example, the one shown in Fig. 1 (*a*) has a No. 20 gauge at one end and a No. 21 gauge at the other end. For settings finer than a No. 23 gauge, strips of paper are sometimes used, although this method is not as reliable as the use of the regular gauges.

2. The *step gauge* (*b*) is composed of one piece with steps, each step being $\frac{1}{16}$ inch thicker than the preceding one. The

first step is generally $\frac{1}{4}$ inch in thickness. The width of this gauge is about $\frac{1}{4}$ inch.

3. The *finger gauge* (c) is measured from the arrowhead on the curved portion to the arrowhead on the straight end and varies from $1\frac{1}{8}$ inches to 2 inches in length; it is about $\frac{3}{16}$ inch in thickness.

4. The *quadrant* (d) is used for determining the angles of top combs.

5. The *cradle gauge* (e) is used to hold the top comb in position while it is being fastened to the comb arms.

6. The *brush gauge* (f) is used for setting the brush shaft parallel to, and at the required distance from, the cylinder shaft.

Assuming that a comber has merely been set up and that the cylinders are loose on the cylinder shaft, the parts that require setting with gauges and the gauges used for making each setting are given in Table I.

TABLE I

Parts to be Set	Gauge	Size of Gauge
Delivery roll from segment	Comber	No. 23
Front flute of segment from delivery roll	Finger	$1\frac{1}{8}$ inches
Feed-roll from delivery roll	Finger	According to staple
Cushion plate to nipper knife	With paper	
Distance of setscrew i_3 from stand when d is down, Fig. 3	Step	$\frac{1}{4}$ to $\frac{3}{8}$ inch
Cushion plate from delivery roll . .	Finger	According to staple
Distance of nipper from half lap when nipper is in its lowest position	Comber	No. 20
Brush to half lap	Brush	
Top comb set at angle of from 25° to 30°	Quadrant	
Top comb from fluted segment . . .	Comber	No. 20 or 21
Distance of blocks l_3, Fig. 8, from bearings of detaching roll when resting on segment	Comber	No. 23
Top roll from leather detaching roll .	Comber	No. 21

3. Setting the Various Parts.—1. In making any setting in any machine, some one point, usually a shaft, is taken as a basis. In the comber, the cylinder shaft is primarily the base of all settings, from the fact that the cylinder, which is used to set from for certain settings, is centered on that shaft; but as the delivery roll is a more convenient point from which to work when making certain of the settings, it is given a true and accurate setting with a certain definite relation to the cylinder, and after being certain that it will revolve freely in its bearings, these bearings are secured, and the delivery roll becomes the base of certain of the settings of the comber.

The cylinder shaft and delivery roll of the comber revolve in bearings that do not have any motion during the various operations of the comber, and which after the first setting have a definite relation to each other as to distance. The fact that the cylinder can be moved on the cylinder shaft does not affect the distance between the faces of the segment, or the half lap of the cylinder, and the face of the delivery roll.

In order to have the cylinder and delivery roll in their proper relative positions, it is first necessary to *line up* the delivery roll, which is done by presenting each fluted segment of the comber to the delivery roll and moving the bearings of the delivery roll until the space between the surface of this roll and the surface of each fluted segment is equal to a No. 23 comber gauge. The distance should be tested at both ends of each segment. When this has been done, the cylinder shaft and all parts carried on the cylinder shaft have a definite relation as to distance from the delivery roll, and although certain settings are made from either base, they do not conflict with one another.

2. *Front Flute of Segment From Delivery Roll.*—After setting the delivery roll and being positive that it revolves very freely in its bearings, the index gear (which will be described later) should be placed at 5, after which the cylinders are fastened on the cylinder shaft. One cylinder is first secured so that the front edge of its fluted segment

approaches within a certain distance of the face of the delivery roll, after which each of the other cylinders of the comber is set with its fluted segment the same distance away. When this has been done, the first flutes of all the segments across the comber will be in one straight line. A finger gauge $1\frac{1}{8}$ inches long may be used, but care should be taken in making this setting that the position of each segment is accurate, since the perfect alinement of these parts is vital to the quality of the product.

When making this setting, the curved face of the finger gauge is placed on the flutes of the delivery roll and the cylinder turned on its shaft until the front part of the segment comes in contact with the opposite face of the gauge. The space between these two parts should first be tested at one end of the segment, and when this end is in its correct position the cylinder is secured by means of a setscrew to the shaft at this end, after which the gauge is passed along the length of the segment to make sure that it is the correct distance at all points from the delivery roll; the cylinder is then fastened at its other end by means of a setscrew. The same method is adopted with each of the other cylinders, care also being taken to have all the cylinders exactly in the centers of the heads.

3. *Feed-Roll From Delivery Roll.*—Setting the feed-roll from the delivery roll is accomplished by moving the bearings of the feed-roll. This is a very important setting, since if these rolls are not exactly parallel, there will be a strain on the fibers at one side and only a partial detachment of the fibers on the other side during the operation of detaching. The feed-roll must also be parallel to the cylinder, otherwise one side of the lap will be combed more than the other. If any of these faults exist, a cloudy and uneven web will be produced. The finger gauge is used for this setting; its curved face should be on the flutes of the delivery roll, while the opposite face should be in contact with the flutes of the feed-roll, but these rolls should not be set so close that the gauge cannot have an easy upward movement. The distance should be tested at both ends of each fluted section.

This setting of the feed-roll varies according to the staple and nature of the stock, as shown in Table II.

TABLE II

Cotton	Length of Staple Inches	Size of Gauge Inches
American	About $1\frac{1}{4}$	$1\frac{11}{16}$ to $1\frac{13}{16}$
Egyptian	Up to $1\frac{1}{2}$	$1\frac{13}{16}$ to $1\frac{15}{16}$
Egyptian and sea-island	$1\frac{1}{2}$ and longer	$1\frac{15}{16}$ to 2

4. *Cushion Plate to Nipper Knife.*—Before setting the nippers, the cushion plate must be adjusted so that the nipper knife, when down, will be in contact with the cushion plate at an even pressure throughout its entire width. If it does not touch along its entire edge, the fibers will be held tightly at one side, while on the other side they will be held loosely. The cotton that is not held securely by the nippers will be pulled out by the half lap and eventually arrive at the waste can, causing a waste of good cotton.

The efficiency of the half lap also depends on this setting. Care must also be taken that the *nose*, or front edge, of the cushion plate is evenly and properly covered, in order that it may present a perfectly even surface along its entire length. In setting the parts, two strips of ordinary writing paper, one at each end of the knife, should be placed between the front part of the cushion plate and the overhanging lip of the nipper knife, and the setting between these parts made as close as possible and yet allow the two strips to be easily drawn from between the lip of the knife and the round nose of the cushion when the knife is in contact with the cushion plate. The same test is then made in the center and between the ends and the center. The fluted edge of the knife should be set so that a narrow strip of paper will be held firmly between the cushion plate and the nipper knife when the knife is pressed down on the cushion plate.

Setting the cushion plate to the nipper knife is performed by loosening three screws similar to h_1, Fig. 2, and moving the

plate to the knife by screws similar to h_5. After the proper setting has been secured, the screws h_4 are screwed as tightly as possible.

5. *Distance of Setscrew From Stand.*—Before the cushion plates are set to the delivery roll, the setscrew i_3, Fig. 3, should be adjusted. In making this setting, it is a good plan to have the screw project through the arm i_2 so that when it is resting against the stand f, the arm i_2 will be in a perpendicular position. This can be accomplished by holding a level on the front face of the arm i_2 and turning

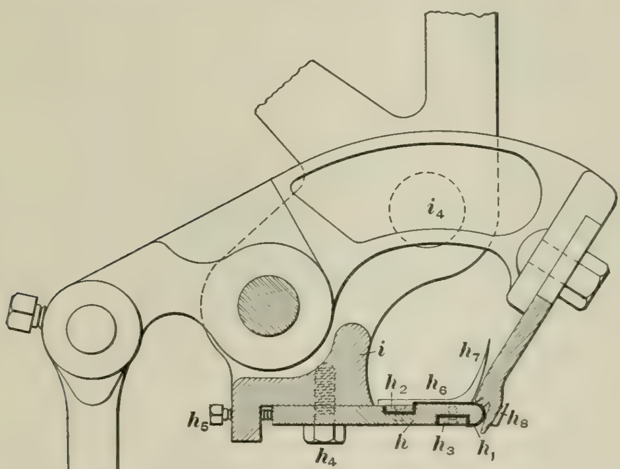


FIG. 2

the screw i_3 until the arm i_2 is in the required position. This should be done at each head. The only object of this setting is to have each head set alike and thus have some definite basis to work from when making future settings.

6. *Cushion Plate From Delivery Roll.*—It is now necessary to set the cushion plates the desired distance from the delivery roll. The position of the cushion plates with relation to the portion i and the nipper knife has been determined and must not be disturbed; therefore, in order to adjust any one of the cushion plates to the delivery roll, the whole nipper mechanism must be moved. In making the setting between the

cushion plate and the delivery roll two operations are employed. In the first case a general setting is made by loosening the bolts (not shown in Fig. 3) that attach the

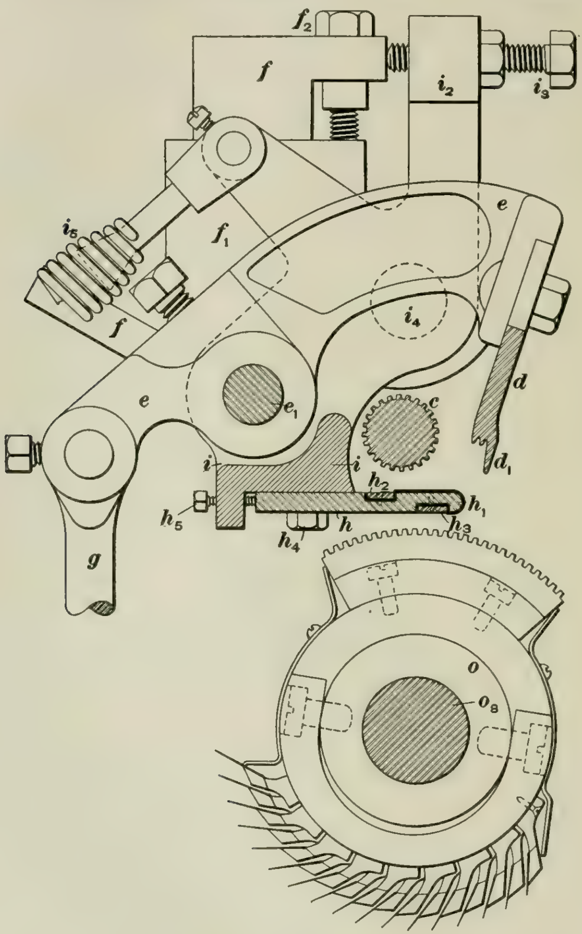


FIG. 3

nipper-mechanism stands f to the framework, and moving this mechanism on the framework nearer to, or farther from, the delivery roll until the cushion plate is exactly the same distance from the delivery roll at each end, which insures

the delivery roll and the nose of the cushion plate being parallel. Afterwards a more accurate setting is made by means of the setscrews i_3.

The entire operation is as follows: After loosening the bolts that attach the nipper-mechanism stands f to the framework, the finger gauge is placed with its curved face on the delivery roll and the nipper mechanism moved forwards until the round nose of the cushion plate is against the straight face of the gauge. This distance is tested at each end of the cushion plate and at intervals between. When the cushion plate has been set parallel to the delivery roll, the nipper mechanism is tightly secured on its seat by means of the bolts. Next, the gauge is again inserted at each end of the cushion plate and at intervals along the plate, and by means of the setscrew i_3 the setting is made so close that the gauge cannot have an easy vertical movement.

As the bracket i that carries the arm i_2 swings on the center i_4, the effect that is produced on the nipper mechanism by moving the setscrew i_3 can readily be seen. The settings of the cushion plate are governed by the length of the staple, the class of cotton, and the weight of the lap used. General settings for this part of the comber are given in Table III.

TABLE III

Cotton	Length of Staple Inches	Size of Gauge Inches
American	$1\frac{1}{4}$	$1\frac{1}{8}$ to $1\frac{3}{16}$
Egyptian	$1\frac{1}{4}$ to $1\frac{1}{2}$	$1\frac{3}{16}$ to $1\frac{1}{4}$
Sea-island	Over $1\frac{1}{2}$	$1\frac{1}{4}$ to $1\frac{7}{16}$

7. *Distance of Nipper From Half Lap When Nipper is in Its Lowest Position.*—The setting of the nipper to the half lap is performed by the sliding bracket f_1, Fig. 3, and setscrew f_2. The bolt holding the sliding bracket f_1 should be loosened and a step gauge placed between the end of the setscrew i_3 and stand f. The object of inserting a step gauge at this

place is to swing the nipper mechanism on the center i_4 until the nipper knife is in exactly the same position that it assumes when the cotton is being combed by the needles on the half lap. A step gauge must therefore be selected that gives the exact throw to bring the nipper knife into the required position. During this setting, however, the nipper knife is pressed down on the cushion plate and the lip d_1 projects beyond this plate. The setting is made by inserting a No. 20 comber gauge, Fig. 1 (a), between the edge of the nipper knife and the needles of the half lap. The cylinder shaft should be turned so that the points of the needles come directly under the edge of the nipper knife. Each end of the nipper is then accurately adjusted by either raising or lowering it by means of the setscrews f_2. The cylinder shaft should then be turned and the gauge inserted between each row of needles and the nipper knife.

When the setting is completed, it should be possible to move the gauge the entire width of the nipper without too much resistance. In passing the gauge between the nipper knife and the needles, it is a good plan to slide the gauge on the edge of the knife, that being a smooth surface. When this setting has been completed, the bolts that hold the sliding brackets f_1 to the stands f should be tightened. The springs i_5 should next be put on and adjusted to the proper tension. This may be done by the nuts on the spring screw. This method of setting is of course adopted at each head on the comber.

8. *Setting the Top Comb.*—One of the top combs should next be set at an angle of from 25° to 30°. When making this setting, the detaching roll should be on the fluted segment in position to detach, and particular care taken to have the top comb set so that it will not come in contact with the nippers or leather detaching roll. The brackets u_1, Fig. 4, should be loose on the shaft u_2 so that they will allow the adjustment of the comb. The screws holding the comb to the brackets u_1 should also be loose. The quadrant gauge is used in making this setting, it being so constructed that its lower part fits over the blade of the comb, to which it

is secured by a thumbscrew. The comb is so set that the plumb-bob on the gauge will fall in a position to give the correct angle, which can be learned from the scale on the gauge. When the top comb is at the correct angle and not in contact with either the nippers or leather detaching roll, the screws that fasten the comb at each end to the brackets u_1, Fig. 4, should be secured.

After one comb has been placed in position with the use of the quadrant gauge, the remaining top combs to be set are in some cases placed in position by what is known as a **cradle**, Fig. 1 (e), which consists of a casting having two bearing points for the comb to rest on and two set-screws that bear against the blade of the comb. By moving these set-screws, the comb may be held at any desired angle. Having set one comb, the cradle is set on the fluted segment, the base of the cradle being curved to conform to the curvature of the segment. The top comb, which has been set by the quadrant gauge, is then lowered on to the cradle and the screws of the cradle regulated so that they just bear against the blade of the comb. After having regulated the screws of the cradle, it is merely necessary, when it is desired to set another top comb, to place it in the cradle and then place the cradle on the fluted segment and secure the comb to the brackets u_1, Fig. 4, while the comb is held in position, after which the cradle is removed.

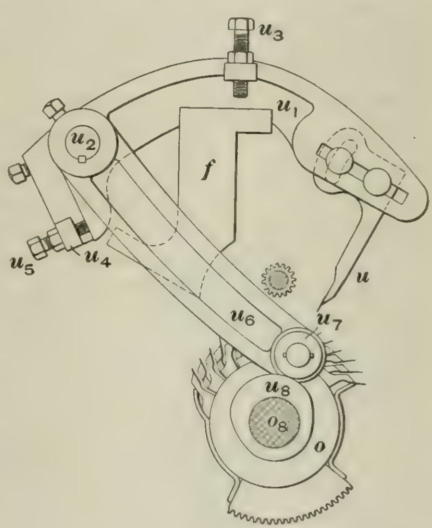


FIG. 4

The quadrant gauge of course could be used for each head, but it saves time and is sufficiently accurate to use the

cradle gauge after the top comb of the first head has been set, especially when a large number of combers have to be set.

9. *Top Comb From Fluted Segment.*—When the top comb has been set to the proper angle, the distance between it and the fluted segment is regulated by means of the screws u_3, Fig. 4. A No. 20 gauge may be used and the comb adjusted so that the gauge will pass between it and the fluted segment without too much resistance. In passing the gauge between the top comb and fluted segment, it is a good plan to slide the gauge on the fluted segment and drop the comb so that the points of the needles can be felt as the gauge passes under them. The same method of setting the top comb is then employed at each head of the comber. When the top combs have all been set the proper distance from the fluted segment, the brackets u_4 should be secured to the shaft u_2 and the screws u_3 adjusted. To accomplish this, the cam u_8 on the cylinder shaft is turned so that the bowl u_7 will be on the part of the cam nearest the center. A gauge about the thickness of a No. 18 comber gauge is placed between the bowl and the cam, and the brackets u_4 secured to the shaft u_2 while it is held in this position. The setscrews u_5 should now be set so that a piece of paper can be drawn between the ends of the screws and the projections on the brackets u_1. These screws should be adjusted so that the paper will be drawn out at an even tension at each head. Care should be taken while this is being done that the screws u_3 are resting on the stands f. After all these brackets have been set, the gauge should be removed and the lever u_6 raised by hand; by watching carefully, it may then be ascertained whether or not the top combs move exactly together.

The last two settings mentioned in Table I are more readily made after certain of the timings have been made, and will be described later.

MINOR SETTINGS

4. Adjusting the Nipper Rods.—The connections may now be made between the nipper cam and the brackets e, Fig. 3, that operate the nipper knife. To accomplish this,

disconnect the cam-shaft from the cylinder shaft by sliding the gear on the cam-shaft out of gear with the one on the cylinder shaft with which it meshes. The cam-shaft should

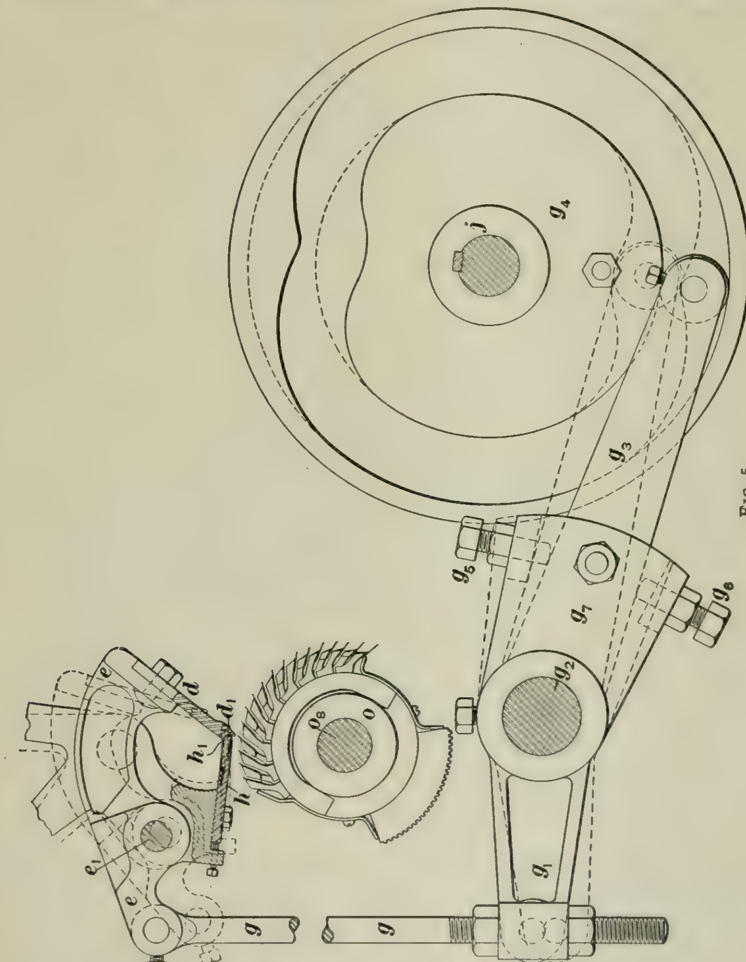


FIG. 5

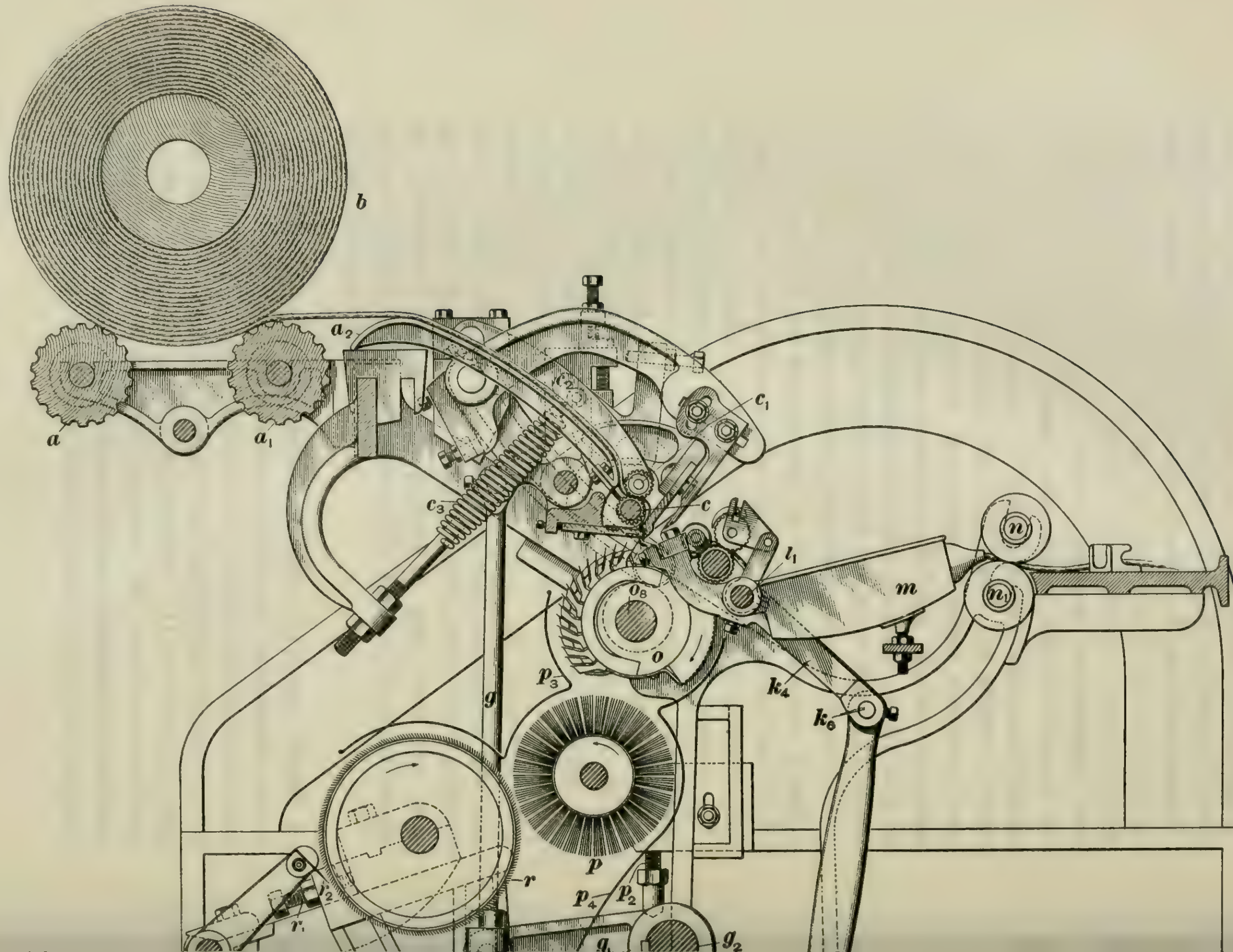
then be turned until the cam-bowl operated by the nipper cam g_4, Fig. 5, is in the position that it should occupy when the cushion plate is at its lowest position; that is, the cam-bowl will be at the toe of the cam, or the point farthest

from the center of the cam, as shown in full lines, Fig. 5. When the cam-bowl is in this position, place the step gauge between the end of the setscrews i_3 and the stands f, Fig. 3, and connect the rod g, Fig. 5, to the bracket g_1 and nipper bracket e, Fig. 3, commencing with the rod nearest the driving end of the machine and setting that rod in each head. These rods should be so adjusted by the nuts at the bottom of the rods that the step gauge may be moved between the stand and the screw i_3 without a great amount of resistance. When this has been accomplished, the other rods of each head similar to g may be connected and adjusted in like manner. After this is done, the step gauge should pass between the ends of all the screws i_3 and the stands f with the same resistance.

The step on the step gauge to be used between f and i_3 depends on the distance that the cushion plate has to be depressed in order to bring it in the proper position for combing; a $\frac{1}{4}$-inch or $\frac{3}{8}$-inch gauge is generally used.

The cam-shaft and cylinder shaft may now be connected. Before this is done these two shafts should be placed in their correct relative positions. First, the cam-shaft should be in the same position that it occupied in making the previous setting; that is, the cam-bowl on the nipper cam should be in a position farthest from the center of the cam. Next, the cylinder shaft should be turned so that the pointer will stand at 17 on the index gear. The gear on the cam-shaft may then be placed in gear with the gear on the cylinder shaft and secured by bolting it to the flange of the sleeve on the cam-shaft.

5. The Revolving Brush.—The revolving brush p, Fig. 6, that cleans the needles on the half lap should be set so that the ends of the bristles will just touch the brass bars that hold the needles. This setting is governed by the extent to which the brush cleans the needles. If it is noticed that waste remains on the half lap after the needles have been brushed, the brush should be set closer, although no attempt should be made to set the brush so near to the half lap that



a
a1
a2
b
c
c1
c2
c3
g
g2
k4
k6
l1
m
n
n1
o
o8
p
p2
p3
p4
q
r
r1

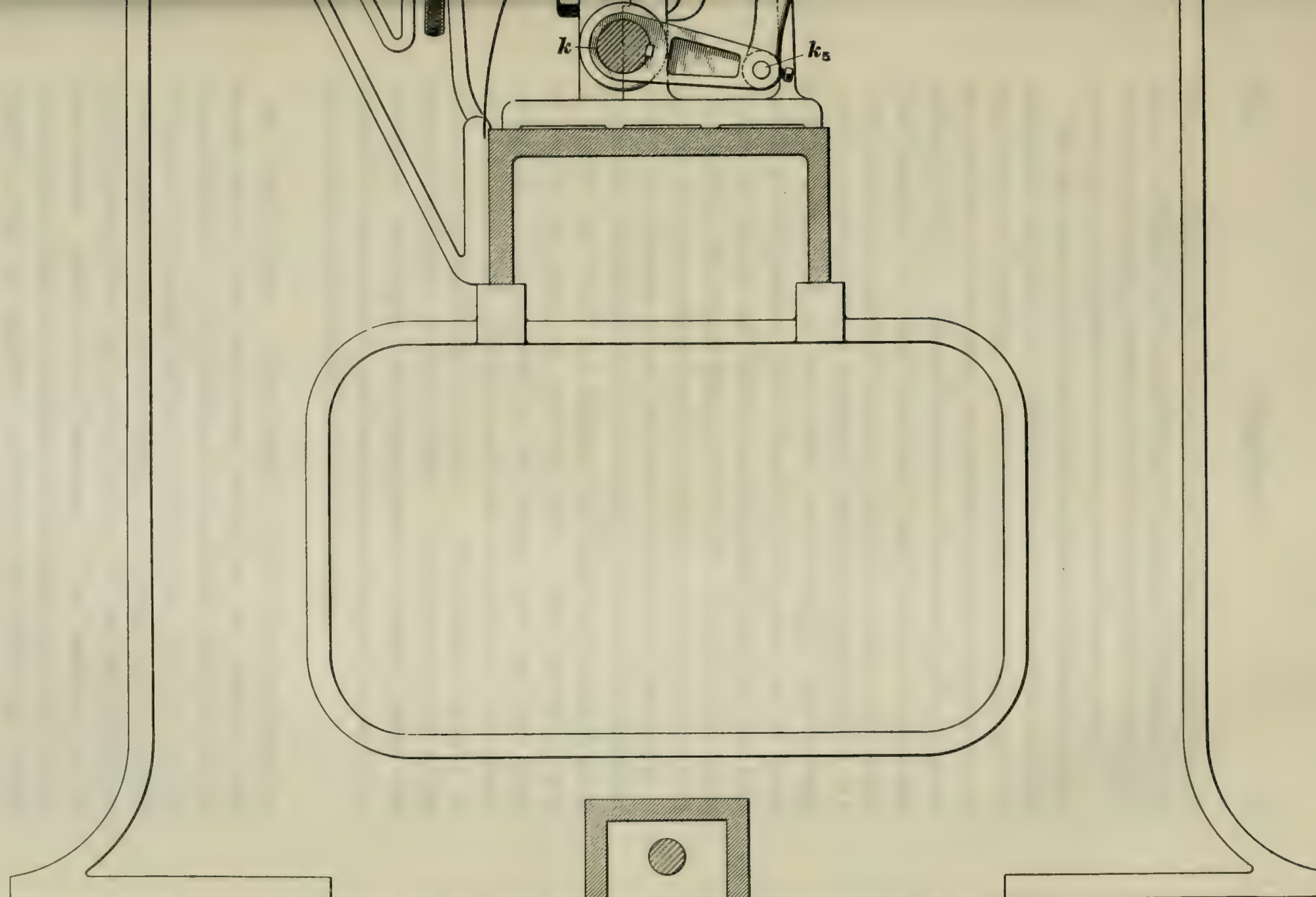


FIG. 6

those small portions of cotton that become wedged in the spaces between the bars holding the needles will be removed, since these small portions are held so firmly that it is usually necessary to pick them out with a piece of sheet metal.

The bearings of the brush shaft are held in slides in upright supports, and when it is desired to set the brushes the nuts that hold the bearings of the brush shaft are loosened and the position of this shaft regulated by screws similar to the screw p_2, Fig. 6. These screws are connected to the brackets that support the brush shaft and their heads are in contact with projections on the framing. An adjustable gauge sometimes used for setting the brush shaft is shown in Fig. 1 (f), and is composed of two parts, one having a slot through which a bolt passes, thus allowing the gauge to be made longer or shorter and held at any desired length by the bolt. One part of the gauge has a curved face similar to the finger gauge, while the other part is brought to a point at one end. When it is desired to set the brush shaft closer, the gauge is set so that the length from the center of the curve to the point is slightly less than the distance between the circumferences of the brush shaft and cylinder shaft. The curved face of the gauge is then placed on the brush shaft and this shaft moved nearer the cylinder shaft until the point of the gauge comes in contact with the latter. The gauge should be tried at both sides of every head. The brushes of the heads are all on one shaft, and consequently in setting them care should be taken not to set one so much out of line with the others that the shaft will bind in its bearings.

6. The Doffer.—The doffer r, Fig. 6, which receives the waste cotton from the brush, should be set about $\frac{1}{16}$ inch from the brush. The bearings of the doffer shaft are moved by means of screws similar to the one shown at r_1, Fig. 6. The doffers for all of the heads are carried on one shaft, and in setting them care must be taken to see that this shaft can revolve freely in its bearings. The bearings of the doffer-comb shaft are attached to the bearings of the doffer shaft, so that the relative positions of the doffer and doffer

comb are not changed when the doffer shaft is set closer to the brush shaft. Adjustments are provided, however, for setting the doffer comb to the doffer by having slots in the brackets that support the comb. The comb should be set about $\frac{1}{16}$ inch from the doffer at the lowest point of its stroke and at an angle of about 30° from the perpendicular at the upper part of its stroke.

7. Top Feed-Roll.—The top feed-roll is now placed in position and adjusted so that it will be parallel with the bottom feed-roll and in such a position that the ends of the arms c_2, Fig. 6, will not come in contact with the ends of the nipper bracket. The adjustment is made by moving the stud on which the arms c_2 are pivoted. The springs c_3 should now be put on and adjusted so that the tension will be equal on both ends of the roller.

The tins that cover the brushes and cylinders should be set square and true and in such a position that they will not be in contact with the cylinders, brushes, or doffers. The lap apron should be placed in position and adjusted so that it is level and true and exactly in the center of the head. The brush for cleaning the feed-roll, which is adjustable on the lap apron, should be so set that the ends of the bristles will just touch the flutes of the bottom feed-roll.

8. Sliver Pans.—The sliver pans should be placed in position and adjusted so that they set squarely on the shaft l_1, Fig. 6, and so that the trumpets are in their proper positions relative to the calender rolls.

9. Draw-Box.—The rolls of the draw-box should be set the proper distances from center to center according to the staple being run. The description of other settings will be better understood after the timing of certain parts has been considered, and therefore will be given later.

TIMING

10. After all the parts are set, the cams must be adjusted so that they will operate the different motions, or place in position the different parts that they control, at exactly the right moment when they are required to perform their work. In order to regulate this timing and indicate the time when each operation should be set in motion or each part in position, it is necessary to take some revolving part of the comber as a basis from which to work and to time all parts in relation to it. The cylinder is taken as a basis, as all the intermittent movements of the comber are completed within the time occupied by one revolution of the cylinder. It is furthermore necessary to have some means of indicating in what position the cylinder should be when each individual motion takes place or each individual part arrives in its proper position.

For this purpose, a gear of 80 teeth, on the cylinder shaft, is divided into twenty equal parts, or sections, which are numbered on the rim of the gear from 1 to 20, each section containing 4 teeth. This gear is known as the **index gear.** A vertical index finger is placed on a stationary part of the comber directly over the cylinder shaft, pointing upwards, and indicates by its relation to the position of the index gear the position of the cylinder.

The numbers are so placed that as the cylinder revolves, No. 1 is first brought opposite the index finger, then No. 2, No. 3, and so on up to 20. Each section of the index gear is spoken of as a whole number, and each tooth in a section is spoken of as $\frac{1}{4}$; that is, if the cylinder has revolved until the comber is said to be at $5\frac{1}{2}$, it indicates that the index finger is at the second tooth beyond the section marked 5 on the index gear, or 22 teeth from the section marked 20. It is sometimes the custom in a mill to read as a clock is read, the position of the gear with reference to the index finger; thus, the above timing would be read as *half-past five.* If the index is at 7, or if it is said to be 7 *o'clock*, it means that the cylinder has been revolved until seven sections, or 28 teeth, have passed the index finger.

From this description it will be seen that if the motions of a comber are listed according to their precedence and the timing of each indicated according to the position of the index gear with relation to the index finger, the timing will be indicated by continually increasing numbers, and a comparison of the timings will show at a glance the relation between the different motions and the relative time that will elapse between them.

The actions to be timed are: (1) The motion of the feed-rolls; (2) the motion of the nippers; (3) the placing of the detaching roll and top roll in position for detaching; (4) removal of detaching roll from detaching position; (5) motions of the delivery roll; (6) movement of the top comb.

11. Timing the Feed.—The time when the feeding begins to take place varies from $4\frac{1}{2}$ to 6, owing to the fact that more waste is taken out of some cottons than others, and the later the feed the more waste is taken out. When combing Egyptian cotton, the feeding is done comparatively early, as the fibers of this cotton do not vary much from the average length, thus requiring the least waste to be removed; consequently, this cotton is the easiest to comb. The fibers of the sea-island cotton vary from the average length more than the fibers of other cottons that are combed, so that sea-island is fed late; Peelers and other American cottons occupy about a central position between these extremes.

When **timing the feed** the cylinder is turned to the desired position and the pin c_4, Fig. 7, so placed that it will just enter the star gear. The position of the disk c_3 that carries the pin may be changed in relation to the index gear b by means of the slot c_8, so that the time that the pin enters the star gear may be altered.

12. Timing the Nippers.—In order to time the nippers, set the index gear at 9 and loosen the nipper cam, which is bolted to a sleeve on the cam-shaft. This sleeve carries a disk that has a slot similar to c_8, Fig. 7, and the cam is fastened to the sleeve by means of a bolt passing through the cam and entering the slot, thus allowing the

cam to be moved on the sleeve. This cam should be fixed on the sleeve in such a position that it will cause the screws i_3, Fig. 3, just to leave the stands when the index gear is at 9. By placing a slip of paper between the screw i_3 and the stand and pulling on it lightly, at the same time turning the driving shaft of the machine, the time when the paper is released will denote the time when the screws i_3 are leaving the stands.

If it is not possible to have the screws i_3 leave the stands when the index gear is at 9, because of the relative positions

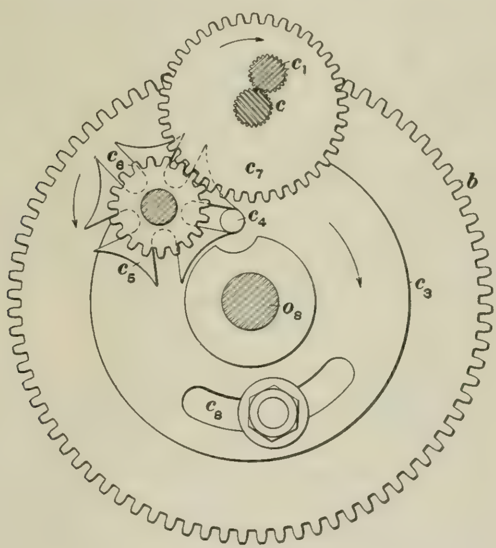


Fig. 7

of the cylinder shaft and the cam-shaft, the gear on the cam-shaft may again be moved out of gear and the cam-shaft turned until the nipper cam is in the desired position, when the gear may again be meshed with the index gear. In order to avoid the liability of having to move the cam-shaft when timing the nippers, the gears on the cam-shaft and cylinder shaft may be meshed when the index gear is at 17 and the bowl on the nipper cam is in the position it should be when the rods g, Fig. 5, are set. The relative

positions of the cylinder shaft and cam-shaft will then be such that the motions received from the cam-shaft may be adjusted by slightly altering the positions of the cams on their respective sleeves, which are keyed to the cam-shaft.

The nipper knife should leave the cushion plate at about $4\frac{1}{2}$; this can also be set by placing paper in the nippers and noting when it is gripped as the driving shaft of the machine is turned. If, after having set the cam so that the screws i_3, Fig. 3, leave the stand at 9, the knife does not leave the cushion plate at exactly the proper time, a further adjustment of the nippers may be made by means of the screws g_5, g_6, Fig. 5.

The lever g_3 gives motion to the nipper shaft g_2 through the casting g_7 by means of the screws g_5, g_6. If, therefore, the nipper cam is not placed in position for the screws i_3, Fig. 3, to leave the stands when the index gear is at 9, the screws on the casting g_7 may be adjusted, changing the relative positions of the nipper shaft g_2 and the cam. These adjustments may be made until the relative position of the nippers with the cam-bowl in the cam-course is correct when the cam-bowl is at any point in the course.

13. Placing the Detaching Roll and Top Roll in Position for Detaching.—The lifter cam j_1, Fig. 8, which controls the leather detaching roll q, next requires adjusting. This cam is mounted and fastened in the same manner as the nipper cam and should be placed in position so that the leather detaching roll will come in contact with the fluted segment when the index gear is at $6\frac{3}{4}$. This may be tested by placing strips of paper on the fluted segment and observing when they are held between the segment and the roll.

14. Distance of Blocks From Bearings of Detaching Roll When Bearing on Segment.—The two last settings mentioned in the list of settings may now be made. The lifter cam should be in such a position that, when the roll touches the segment, the blocks l_3, Fig. 8, will not be in their lowest positions, but will continue to move down as the cam revolves. When the blocks l_3 are in their lowest

positions, there should be a space between them and the brass bushings of the leather detaching roll equal to a No. 23 comber gauge. The blocks may be adjusted by the screws l_4, Fig. 8, so that the distance between them and the brass bushings may be regulated when the cam has lowered the

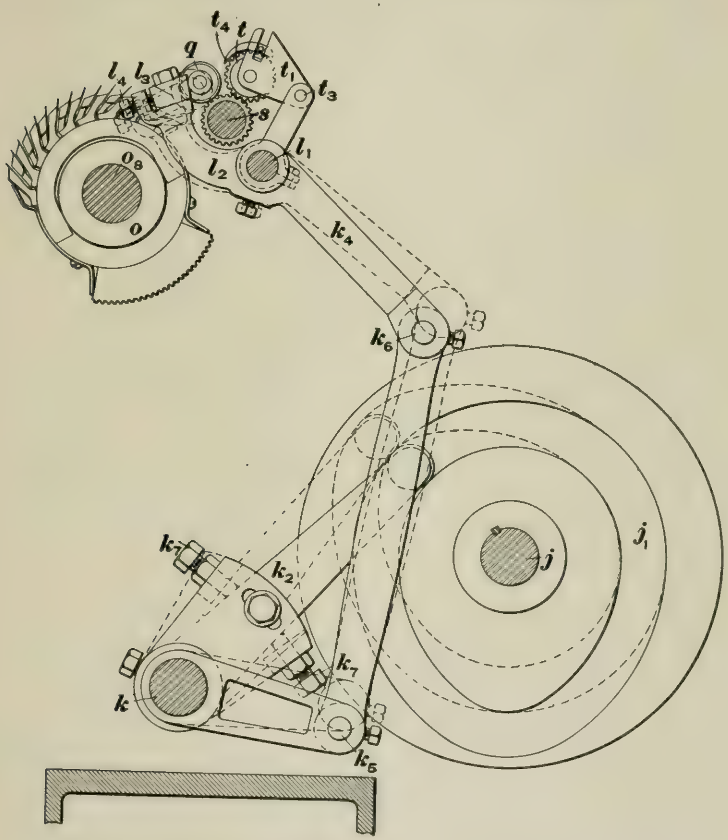


FIG. 8

blocks as far as possible. When this setting has been made as described, it is certain that the detaching roll is properly in contact with the fluted segment.

15. Setting the Top Roll From Leather Detaching Roll.—When the detaching roll is properly in contact with

the fluted segment, the top roll should be set from the detaching roll with a No. 21 comber gauge. This is accomplished by loosening the setscrews that hold the supports for the bearings of the roll to the shaft l_1.

16. Removal of Detaching Roll From Detaching Position.—The lifter cam should now be in position so that, in addition to causing the detaching roll to come in contact with the segment at $6\frac{3}{4}$ and moving the blocks the required distance from the bushings, it will also remove the detaching roll from the segment at $9\frac{1}{2}$. This can also be tested by paper placed between the segment and the roll, which should release the paper at $9\frac{1}{2}$. If the cam is in its proper position when the detaching roll touches the segment, but is not in a position to remove the detaching roll at the proper time, it can be remedied by an adjustment provided on the lever k_2, Fig. 8, similar to the one described in connection with the lever g_3, Fig. 5. This adjustment is for the purpose of regulating the position of the lifter shaft k in relation to the cam, so that the latter may be in a position to place the roll in the correct positions at the given times. Any adjustment made by the screws k_7 will change the distance between the blocks l_3 and the brass bushings on the leather detaching roll.

17. Timing the Motions of the Delivery Roll.—The cam that gives to the delivery roll the rotary motion, which is transmitted to the detaching roll and the top roll, should be set so that when the index finger is at about $1\frac{1}{2}$, the cotton will be started back to be pieced up and, when the index is at about 6, this motion should be reversed and the cotton delivered. The cam that places the pawl of this motion in and out of contact with the gear v_4, Fig. 9, is joined to the cam that imparts the rocking motion to the pawl and, when the latter cam is set, the former is usually very near its correct position. It is capable of being adjusted independently, however, so that it will correctly govern the time that the pawl is placed in, and taken out of, contact with the gear v_4. The pawl is allowed to come in

contact with the gear when the index gear is at about $1\frac{1}{4}$, the time that this pawl is placed in contact with the gear and taken out of contact governing the amount of overlap in the piecing. The usual amount of overlap is about $\frac{3}{4}$ inch, or practically half the length of the fibers.

18. The Top Comb.—The time when the top comb should first be down varies from 5 to 6. The top comb should always be down when the detaching commences. The timing of the comb may be regulated by moving the

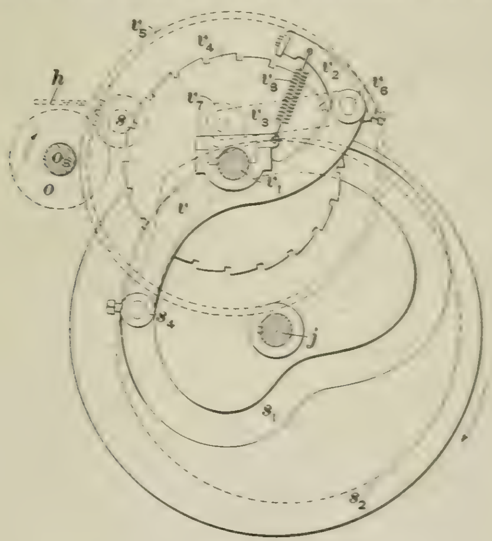


FIG. 9

cam u_3, Fig. 4, which is on the cylinder shaft and imparts motion to the top-comb shaft u_2.

19. In regard to settings and timings it may be stated that more waste may be removed by feeding at a late period, by nipping later, by closer settings of the nippers and top combs to the cylinders, and by increasing the angle of the top comb. The following are good settings and timings for a comber running a lap of 260 grains of Egyptian cotton with a staple of $1\frac{3}{8}$ inches and removing about 16 per cent. waste:

Feed-roll from delivery roll . .	$1\frac{1}{16}$-inch finger gauge
Cushion plate from delivery roll	$1\frac{3}{16}$-inch finger gauge
Distance of screws i_3 from stands	$\frac{1}{4}$-inch step gauge
Distance of nipper from half lap	No. 20 comber gauge
Angle of top comb	28°
Top comb from fluted segment .	No. 20 comber gauge
Distance of blocks l_3 from bearings of detaching rolls	No. 23 comber gauge
Top roll from leather detaching roll	No. 21 comber gauge
Feeds at	5, index gear
Nipper knife leaves cushion plate at	$4\frac{1}{2}$, index gear
Nipper knife touches cushion plate at	$8\frac{3}{4}$, index gear
Leather detaching roll touches segment at	$6\frac{3}{4}$, index gear
Leather detaching roll leaves segment at	$9\frac{1}{4}$, index gear
Delivery roll reverses at	2, index gear
Delivery roll delivers at	$6\frac{1}{2}$, index gear
Top comb down at	6, index gear

20. Because of the difference in construction between double- and single-nip combers, there is a slight difference in timing. This is shown by the following comparison of these types when equipped with the quadrant motion. This timing is for sea-island cotton.

	Single-Nip	Double-Nip
Feeds at	5	$4\frac{1}{2}$ and $14\frac{1}{2}$
Nippers close	$9\frac{1}{4}$	$9\frac{1}{4}$ and $19\frac{1}{4}$
Leather detaching roll touches segment	$6\frac{3}{4}$	$6\frac{3}{4}$ and $16\frac{3}{4}$
Delivery roll reverses	$20\frac{3}{4}$	$20\frac{3}{4}$ and $10\frac{3}{4}$
Delivery roll delivers	6	$6\frac{3}{4}$ and $16\frac{3}{4}$
Top comb down	$5\frac{1}{2}$	$4\frac{1}{2}$ and $14\frac{1}{2}$
Clutch thrown in	$20\frac{1}{2}$	$20\frac{1}{2}$ and $10\frac{1}{2}$

21. In some cases where especially fine yarns are to be produced, the percentage of waste taken out by the combing

is not considered sufficient and **double combing** is performed. Where this process is used, the cans of sliver delivered from the combers may be placed at the back of the sliver-lap machine and the entire process repeated, or as is more often done, the cans may be placed at the back of a ribbon-lap machine that, instead of having lap rolls, has a back similar in construction to that of the sliver lap, each delivery, however, being fed only 8 or 10 ends. The laps from this machine are then placed on the lap rolls of the comber. After the combing operation the cotton is subjected to the drawing processes, whether it has been combed once or twice.

MANAGEMENT OF THE COMBER ROOM

22. Important Points.—As the comber room uses only the best cotton, from which the finest and the special grades of yarn are produced, there are a great many important points to be looked after, especially those in relation to economy.

1. The *needles* on the half lap should receive careful attention and any that are bent or crooked should be straightened by a pair of special pliers provided for this purpose. If there are too many bent or broken needles, the half lap should be taken out and new needles put in. Extra half laps are usually provided so that the machine will not have to remain idle during the time that a half lap is being repaired.

If the several matrices to which the needles are attached are not carefully joined to each other, there will be a large accumulation of waste, which will become so strongly fastened that the brush will not be able to remove it. These collections of cotton should be removed by hand at the back of the comber.

2. The *brushes* that clean the half laps should have the waste removed from their bristles about once a month. When performing this operation, a rake, shown in Fig. 10, is used. When cleaning the brushes, the feed-roll should be thrown out of gear and the ends allowed to run through so

that the dust will not get into the good cotton. The laps should also be protected by a cloth.

As the bristles on these brushes wear down, they should be readjusted so as to be kept in contact with and clean the cylinder needles. As the brushes become smaller by the bristles being worn down, it is sometimes found necessary to change the speed of the brush shaft. Through continued wear and readjustment the bristles become short and soft and the old brushes should then be replaced by new ones. When replacing the old brushes with new ones, a complete new set should be used and care should be taken that they are all of equal diameters, as all the brushes for the heads of a comber are mounted on one shaft.

3. The condition of the *leather detaching roll* has much to do with the quality of the work. This roll should be perfectly true and should be varnished about once a week.

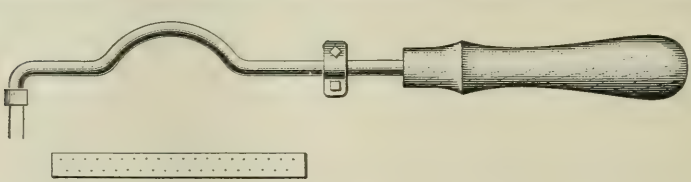


FIG. 10

Care should also be taken in oiling this roll to see that sufficient oil is put on its bearings to give them proper lubrication, and at the same time that the amount is not so large that the oil will run out on the web and cause bad work. Thick and thin places in the web are sometimes an indication that the detaching roll is in poor condition, that is, improperly covered or varnished, or that the bearings of the roll are not properly lubricated. This defect may also be caused by the detaching roll not touching the segment at the proper time.

4. *Top combs* should be looked after very carefully, since if the needles are bent, hooked, or broken out, the web of cotton will be stringy when it enters the pan, due to the fact that the cotton passing through is not properly combed by the top comb. These should be brushed out twice a day with a

stiff brush furnished for this purpose. They should also be looked over once a week, when the needles should be straightened and smoothed or, if in the opinion of the one looking them over, their condition is not good enough, the top comb should be taken out and reneedled. If the points of the needles are only slightly damaged, they may be remedied by being rubbed with a piece of fine emery cloth fixed to a board.

5. The *table*, *table calender rolls*, and *top of the coiler* should be cleaned and polished with whiting twice a week and all dirt kept from these parts of the machine.

6. The *pans* should be wiped out with whiting at least once a week and should always present a bright appearance; all dirt should be kept out of the flutes of the feed-rolls, delivery rolls, and top rolls.

7. While cleaning the front of a comber the machine should be stopped, because all loose fly, dirt, and dust that have been taken out of the cotton and have accumulated on the parts to be brushed are liable to return to the combed cotton. When starting the comber, the end should be broken at the coiler and allowed to run about half a minute before it is pieced up, to insure that no dirty cotton passes through with the good cotton into the can.

The ceiling should be brushed and hangers and pulleys cleaned at a time when the combers are not running. When the combers are started again after the ceiling has been cleaned, the ends should be broken at the coiler and all dirt brushed from the front of the comber before the end is pieced up.

8. In the comber, *single* and *double* should be looked out for. If an end breaks on the table or in one of the pans and the other five ends continue to run through the draw-box, it makes the resulting sliver too light. Whenever an end is seen to be broken, it should be pieced up and the sliver that has been delivered into the can for the period that the end has been broken should be removed. In the case of double —that is, where one end has broken on the table and after a time has doubled on itself and been drawn along by the

friction of the other slivers—the amount of sliver delivered into the can during that period should also be removed.

23. Oiling and Cleaning.—In the comber, as in every other machine in a mill, certain parts must be oiled; this should be periodically attended to. All the more important parts ought to be, and generally are, oiled by one whose special duty it is to attend to this. These parts consist of all the gearing and motions that need oiling in the headstock of the comber, all the cam-courses and cam-bowls and the loose pulleys. If the cam-courses and cam-bowls are allowed to become dry, the bowls will wear away very quickly and become too small for the course, thus causing bad work.

About once or twice a year all the working parts of the comber should be taken down, thoroughly cleaned, and any parts needing repairs should be attended to, such as cushion plates recovered, needles repaired, new brushes put in, or the fillet on doffers replaced. When this has been attended to, the parts should be put together and set as previously described.

24. Waste.—The amount of waste being removed by the various machines combing different kinds of cotton should be ascertained often enough to insure that the proper percentage of waste is being taken out. This is done as follows: After making certain that the laps are all right and that the comber is working properly, the waste cans at the back are removed and boards placed on supports in such positions that the waste will be delivered from the doffers on the boards. The boards generally used for this purpose are about $\frac{3}{8}$ inch thick and have their tops varnished in order to obtain a smooth surface. The comber is then operated until the doffer comb is at the lowest part of its swing, after which the waste at the back is all removed and the sliver broken at the point where it is leaving the front calender rolls. The comber is next started and allowed to run until it has made about 40 nips. The cotton delivered by the front calender rolls is then kept as one portion, while the waste delivered on the boards is taken as another portion. These two portions

of cotton are placed on a pair of scales, Fig. 11, which, instead of denoting weight, denotes the percentage of waste.

Another method for finding the percentage of waste is to weigh each portion and add the weight of waste to the weight of combed cotton and divide this result into the weight of the waste. If the comber is taking out too much or too little waste, any of the settings and timings that have been described as regulating the amount of waste may be changed. The amount of waste will vary under the very

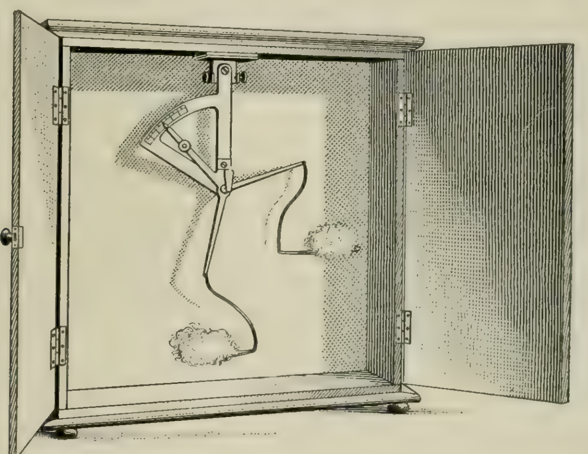


FIG. 11

best circumstances from 1 to 3 per cent., and due allowance should be made for this.

EXAMPLE.—If 60 grains of sliver is delivered from a certain comber in a given number of nips and the waste amounts to 15 grains, what percentage of waste is being removed?

SOLUTION.— 60 gr. weight of sliver
15 gr. weight of waste
75 gr. total weight
15 ÷ 75 = .20, or 20 per cent. Ans.

25. Speed of Comber.—In speaking of the speed of a comber it is said to make so many **nips** per minute and not revolutions per minute, as in the case of the other machines that have been described. By this is meant that every time

the nipper jaws close a nip is made, which in the case of a single-nip comber is one for each complete revolution of the cylinder shaft. In the double-nip machine the comber makes two nips to every complete revolution of the cylinder shaft. A good working speed for a single-nip comber is about 85 nips per minute, while a double-nip comber produces good work when running 120 nips per minute.

26. The weight of a comber with six heads is about 3,500 pounds, and with eight heads 4,500 pounds. A single-nip comber with six heads requires $\frac{5}{8}$ horsepower and with eight heads $\frac{3}{4}$ horsepower, while a double-nip comber of six heads requires $\frac{3}{4}$ horsepower and with eight heads $\frac{7}{8}$ horsepower. The floor space occupied by a single nip 6-head machine for $8\frac{3}{4}$-inch laps, and also for an 8-head machine of the same type is about 13 feet by 3 feet 5 inches and 16 feet by 3 feet 5 inches, respectively.

The production of a single-nip comber varies from 225 pounds to 450 pounds per week of 60 hours, while the production of a double-nip varies from 300 pounds to 550 pounds per week of 60 hours.

FLY FRAMES

(PART 1)

GENERAL CONSTRUCTION OF FLY FRAMES

INTRODUCTION

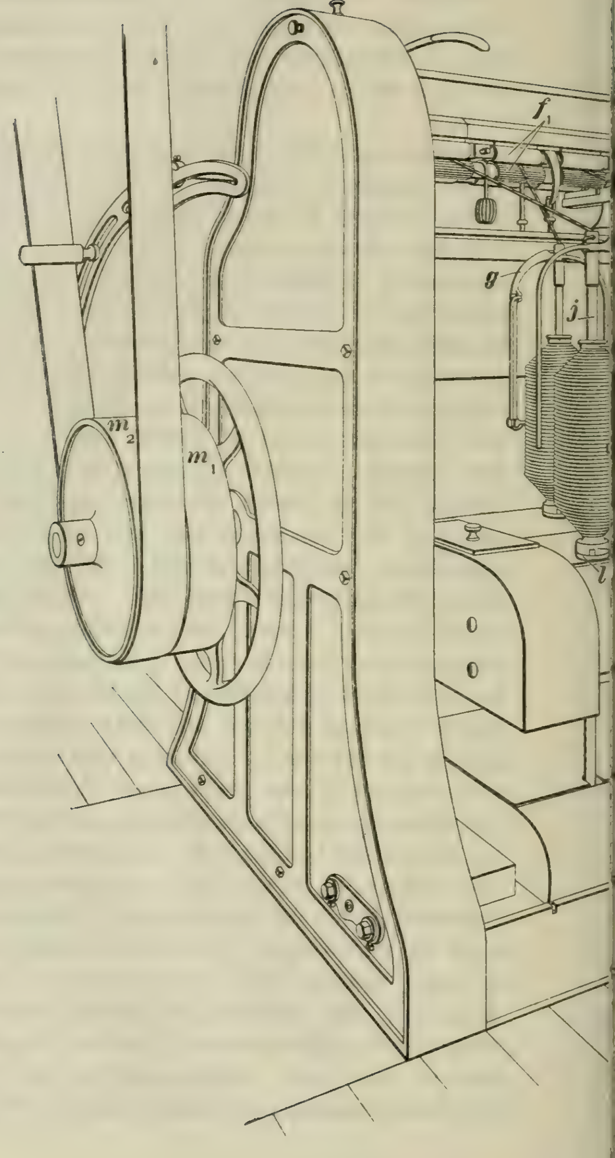
1. After the sliver has been formed at the card and its structure improved at the drawing frames or perfected by the use of combing machinery, much foreign matter and impurities have been removed from the raw stock, the fibers have been carded, straightened, and laid parallel to one another, and the sliver has been evened throughout its whole length, but it is still in too bulky a form and must be further attenuated before it is sufficiently fine to be run through the machine that completes the operation of making it into yarn.

In addition to attenuating the sliver until the required weight per yard is obtained, the opportunity is also taken, in several machines, to multiply the number of doublings, which not only tends to retain the evenness of the sliver produced at the drawing frames, but also to improve on it. The sliver, as it is attenuated by the processes that follow the drawing frames, is known as **roving**; an idea of the extent to which this roving is drawn out before it is considered suitable to be spun into yarn by the mule or spinning frame may be gained by considering that a common weight for sliver at the drawing frame is 60 grains to the yard, from which roving weighing 1.19 grains to the yard is commonly made before being spun into yarn, the sliver thus having been reduced in weight in about the proportion of 50 to 1. For finer work a sliver of

45 grains to the yard might be made into a roving of .3 grain to the yard or an attenuation in the proportion of 150 to 1. It would be impossible to properly perform this attenuation by one process, and consequently the cotton must pass through three or four machines before going to the mule or spinning frame.

The machines used in modern mills to effect this attenuation are known collectively as **fly frames**, although sometimes called **speeders.** The expression fly frames should be applied generally to all these frames as at present constructed, since the term speeder really refers to a machine that is not now made and is only in use to a very small extent. It is probable, however, that the term has obtained such a hold in some manufacturing districts that it will never pass into disuse. Fly frames are divided into *slubbers*, *intermediates*, and *roving frames* where three frames are used between the drawing and spinning frames. Where four frames are used they are generally known as the *slubber*, *intermediate*, *roving frame*, and *jack frame;* in this case the word jack is used to indicate a fine roving frame, sometimes called a *jack roving frame.* The frame following the intermediates is sometimes called a *fine frame.* A much better method of naming the machines, which is used in some parts of the United States and should be uniformly adopted, is to speak of the first machine after the drawing as the slubber; the last machine before the spinning as the roving frame; while the intermediates, if more than one in number, are spoken of as the first and second intermediates, respectively.

All the machines classed under the head of fly frames are practically of the same type of construction, the only differences being in the details. One point to be noted, however, is that since the roving is gradually drawn finer at each succeeding process, it is necessary that certain parts of the intermediate frame should be smaller than the same parts of the slubber, in order to accommodate themselves to the decreasing size of the roving; the same is also true in regard to the roving frame as compared with the intermediate.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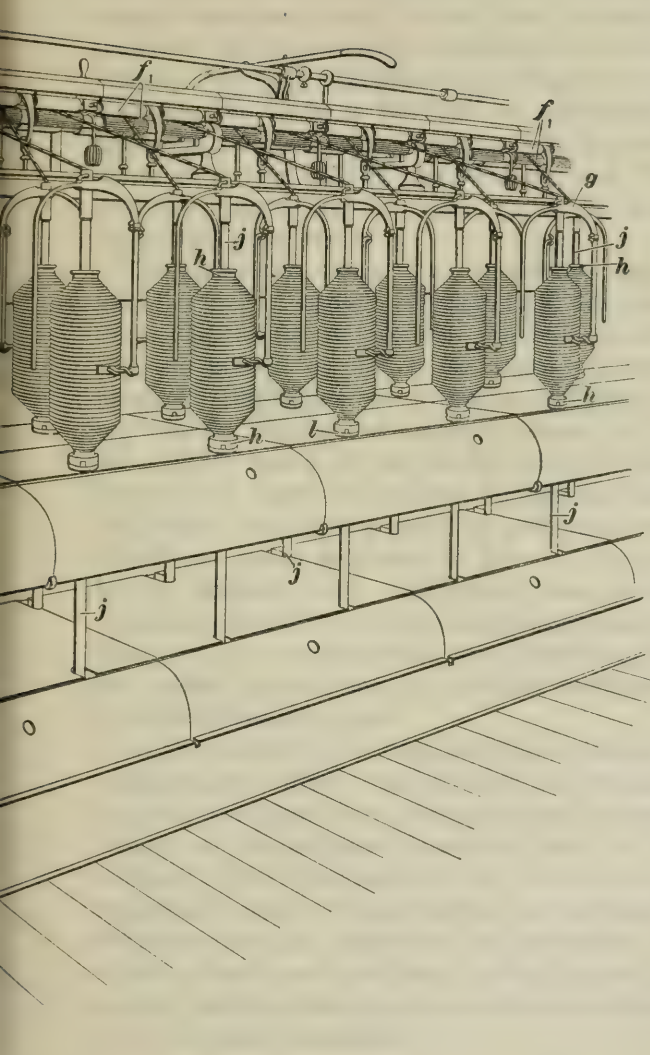


. 1

2. Fly frames have as their objects: (*a*) the reduction of the thickness of the sliver, (*b*) the evening of the product, (*c*) the twisting of the roving, (*d*) the winding of the roving on a bobbin. The attenuation of the sliver renders the third object necessary, since, as the sliver is reduced in size, it naturally becomes weaker and must be twisted in order to enable it to hold together in passing to the next process. Twisting the sliver is followed by winding it on a bobbin, since the reduced sliver must be laid in such form as will allow it to be rapidly revolved around a spindle. The last two objects will be found to be far more difficult of attainment than the first.

The principles adopted to obtain the objects mentioned are: (*a*) roll drafting; (*b*) doubling; (*c*) securely holding the roving at two points, viz., the bite of the delivery rolls and the bobbin on which the roving is wound, and also passing it through what is known as a *flyer*, which revolving rapidly inserts the necessary twist; (*d*) having either the surface speed of the bobbin exceed the speed of the flyer or the speed of the flyer exceed the surface speed of the bobbin, the excess speed of one part over the other in either case being sufficient to take up the roving delivered by the delivery rolls. Although these are the four main principles, several minor mechanical problems present themselves in the construction and operation of fly frames and are solved by the adoption of other mechanical principles, as will be observed later.

As previously mentioned, slubbers, first and second intermediates, and roving frames differ very slightly in construction, the principal point that would be noticed by a person looking at the different machines being in the manner of feeding. With the slubber, the cans from the drawing frames are placed directly behind the machine and the sliver fed from the cans, while with the fly frames that follow the slubber, creels are provided in which to set the bobbins of roving, which is the form in which the cotton is delivered by all of these machines.

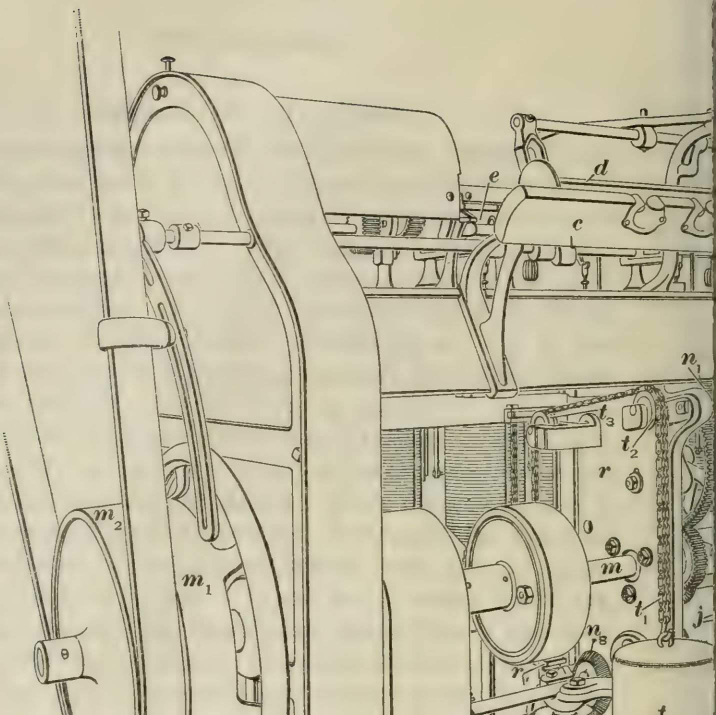
THE SLUBBER

PASSAGE OF THE STOCK

3. As the **slubber** may be considered the simplest form of fly frame, and as it is the first machine in the series, it will be referred to in giving a general description of the construction of these machines. Fig. 1 shows a front view of a portion of a slubber, while Fig. 2 gives a view of the back of the same machine; Fig. 3 is a cross-section through the essential parts of the machine. Referring to Fig. 3, the cans *a* that come from the finisher drawing frame are placed behind the slubber and the sliver *b* passed to the guide board *c*. In the slubber, which in this respect is unlike any of the other fly frames, no doubling takes place, each end of sliver being treated individually. From the guide board *c*, the sliver passes over the lifter roll *d*, through the traverse guide *e*, and then through three sets of rolls f_3, f_2, f_1, which insert the necessary draft. From the drawing rolls, the sliver passes through the upper part of the flyer *g* and then out at its lower part, where it is wound around an arm supported by the flyer. From this arm, the cotton, which having been reduced in size by the drawing rolls of the slubber is now known as roving, passes to the bobbin *h*, on which it is compactly wound. The flyer *g* is supported by the spindle *j*, while the bobbin *h* rests on a flange that forms the upper part of the gear h_1. The gear h_1 is known as the bobbin gear and revolves loosely on the bolster *k*, Fig. 9. In Fig. 3, two ends are shown at the front, although for convenience only one sliver is shown at the back. Each end shown at the front is produced from a separate sliver fed behind the frame.

PRINCIPAL PARTS

4. The *guide board c* through which the sliver passes as it comes from the can is simply a long board with guide holes cut in it at suitable intervals, to prevent one sliver from coming in contact with another. The *lifter roll d* extends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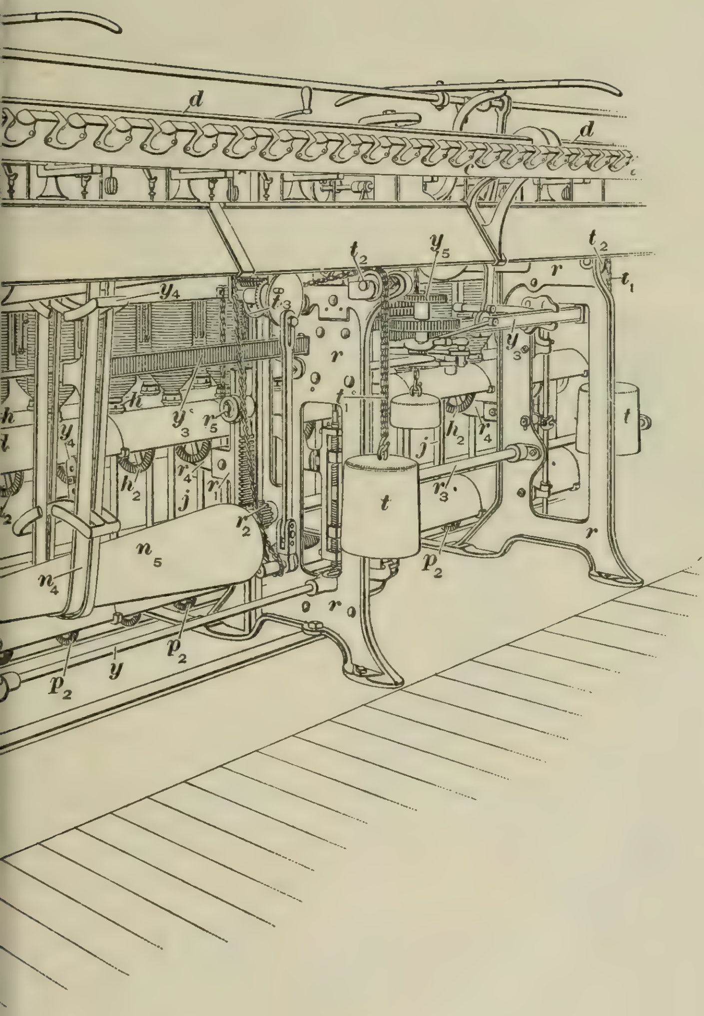
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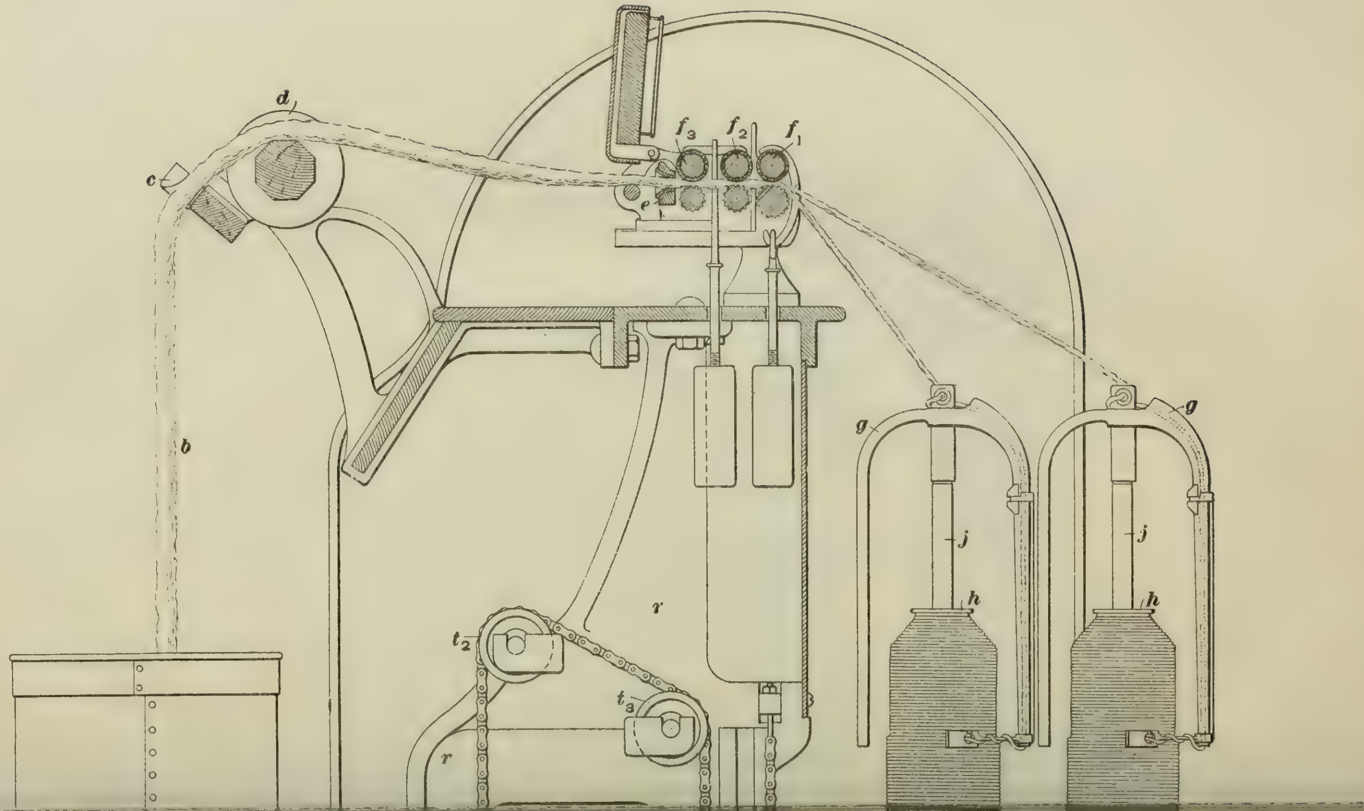
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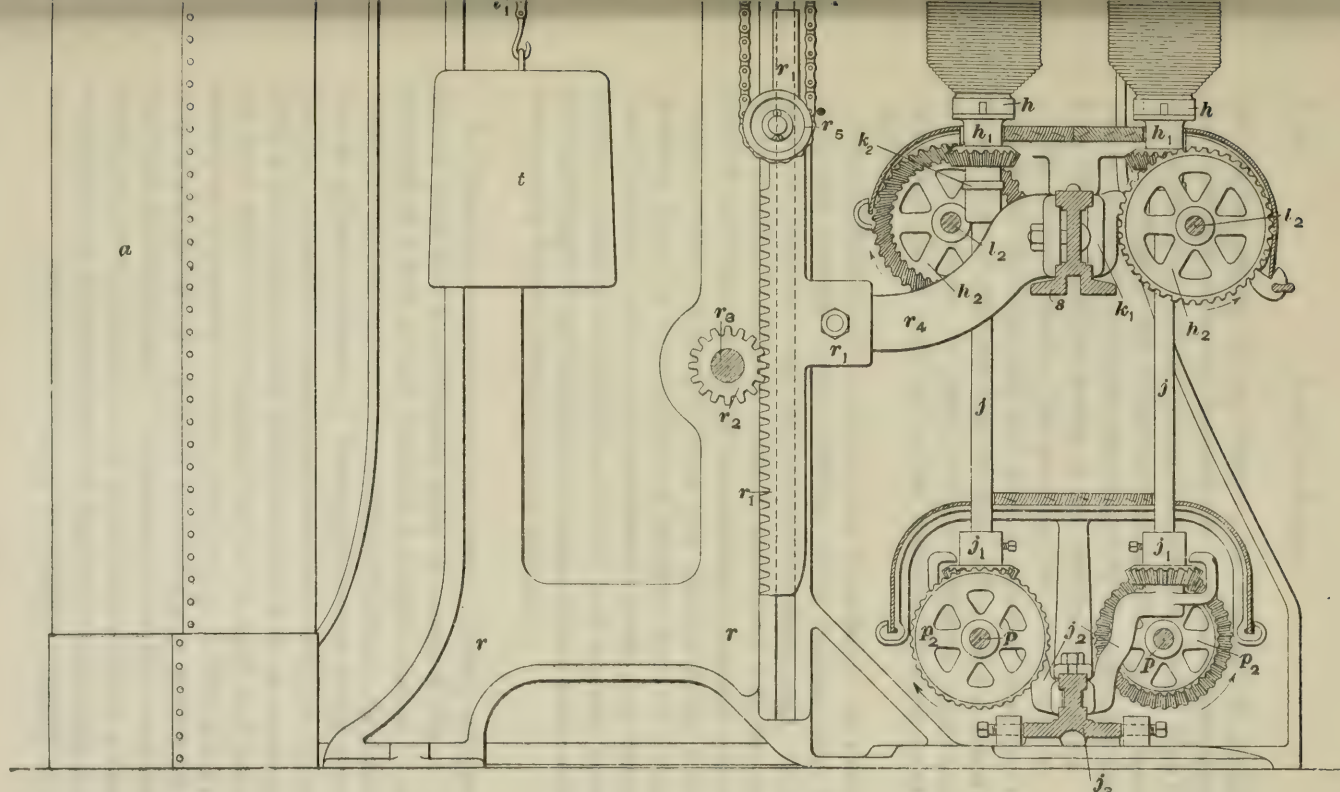
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FIG. 3

the entire length of the frame. At one end it carries a sprocket gear driven by a chain that derives its motion from a sprocket gear on the bottom back drawing roll. The lifter roll revolving in the direction in which the sliver is moving serves to reduce the strain that would be brought on it should it be drawn up by the action of the drawing rolls alone.

The *traverse guide* e, by guiding the sliver first to one part of the drawing rolls and then to another, prevents continual wear on any one part of the rolls. As the objects of traverse motions as well as their different constructions have been dealt with, no further mention of them need be made here.

The *drawing rolls* of a slubber may be either of the metallic or of the common type, although when running very fine work the common rolls are almost universally used. In the fly frames that follow the slubber, which deal with the stock after it has been attenuated considerably, common rolls are almost wholly adopted. There are usually three sets of drawing rolls in fly frames, and whether metallic or common, they are similar in construction to those in a drawing frame. Clearers are also provided for both top and bottom rolls, although it is frequently the custom to run intermediate and roving frames without bottom clearers.

5. The Flyer.—A view of the **flyer,** to which the cotton passes from the front drawing rolls, is shown in Fig. 4. It consists of a *boss* g_1 that contains a hollow portion g_2 into which the spindle projects, two downward projecting *arms*, or *legs*, g_3, g_4, and a *presser* g_5. The upper portion of the boss of the flyer is carefully rounded and smoothed and at its top contains a hole that extends downwards and has an opening g_6 on each side. The projecting leg g_3 is solid and serves simply as a balance for the other leg g_4. The leg g_4 is hollow and carries two lugs, or projections, g_7, g_8 that act as bearings for the presser. The presser, or as it is sometimes called, the *presser finger*, is, as shown in the figure, a round rod hooked at its upper end and bent to a right angle at its lower end. The hollow leg g_4 is slightly tapered at its

lower end, and the presser is so shaped at this point that it forms a circular clamp through which the lower end of the leg g_4 is passed. The inner part of the presser is flattened out into a palm, or paddle, g_9 and is formed with a guide eye. The horizontal part of the presser is of such a length that the guide eye in the palm always comes about opposite the center of the bobbin when the bobbin is empty. The roving in

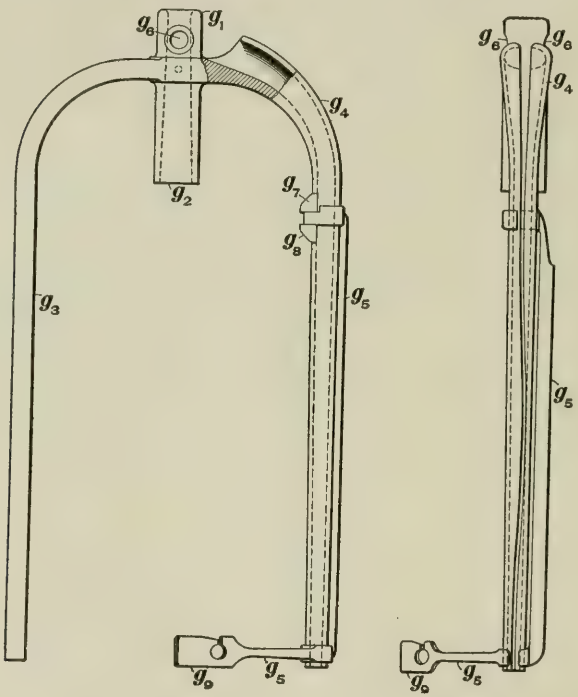


FIG. 4

coming from the delivery rolls passes into the hole at the top of the boss of the flyer and out through the opening at the point g_6, as shown in Fig. 4. It is then wound partly around the boss, passes down the hollow leg g_4, and is wrapped around the horizontal part of the presser once or twice. It then passes through the guide eye in the palm to the bobbin, on which it is wound. Wrapping the roving twice

around the horizontal arm of the presser is the more common practice, although when flyers are new and comparatively rough once around will be found to be sufficient. If the leg g_4 of the flyer were made perfectly tubular, it would be difficult to thread the roving through it in case of breakage. Therefore, the hollow leg is not completely closed, but an opening remains from top to bottom, shown slightly curved in Fig. 4, through which the end of roving may be passed. As this slot is curved it prevents the roving flying out when the flyer is revolving at a high speed. Sometimes, especially for coarse work or machines that are not intended to run at a high speed, the slot is straight.

The flyers are carefully constructed of such a quality of material as will take and maintain a high polish, as it is necessary that all the parts of the flyer with which the cotton comes in contact shall be perfectly smooth. Otherwise, there is a tendency to develop undesirable friction as the roving passes through the eye and down the leg of the flyer, and in some cases small lumps of cotton are thus formed, which pass forwards at intervals, deteriorating the quality of the yarn.

Certain parts of the flyer have an important bearing on the hardness or softness of the bobbin that is made. By this is not meant the hardness or softness of the roving itself, which is determined by the amount of twist inserted, but the feel of the completed bobbin. If the roving were wound on the bobbin without the application of any pressure, the result would be a soft, loosely wound mass of material. To prevent this the flyer is so constructed that the palm g_9 exerts a slight continuous pressure on the bobbin as the roving is being wound thereon. This is done by making the vertical rod of the presser sufficiently heavy to tend to fly outwards as the flyer revolves, which it does at a high speed. The result of this is to throw the palm g_9 inwards, since the vertical rod is capable of swinging partially around the leg g_4. There is some tendency also for the palm itself to fly outwards due to centrifugal force, but the excess weight of the vertical rod and its greater distance from the spindle

are sufficient to overcome the centrifugal force of the palm g_9 and bring a slight pressure constantly to bear on the bobbin.

By altering the relative weights of the vertical rod and the palm, almost any degree of firmness of the full bobbin can be obtained, but this is a point for the machine builder to experiment with and decide on before building the frame, and should not be changed after the machines are installed in the mill unless so advised by the builders.

Bobbins can be made harder by inserting more twist in the roving, as well as by increasing the pressure of the palm on the bobbin.

6. The Spindle.—The **spindle,** as shown in Figs. 3 and 5, is a long steel rod. Its upper end, which is tapered, extends into the hollow part g_2, Fig. 4, of the flyer, where it comes in contact with a wire pin that is fitted into holes bored in the sides of the flyer. This pin fits into the slot in the upper end of the spindle and in this way the two parts are made to act as one. At its lower end the spindle is slightly reduced in diameter, and at its extreme end tapers to a point. This end of the spindle rests in a footstep, which is generally a recess in a bracket, except on English types of frames, where it is a removable piece of metal.

Spindles are made of hardened steel and ground to exact dimensions. They vary from $\frac{5}{8}$ inch to $\frac{7}{8}$ inch in diameter according to the frames for which they are intended, being of smaller diameter and shorter on roving frames and of greater diameter and longer on slubbers. The spindles in all fly frames are arranged in two rows, one behind the other. The spindles in the back row do not come directly behind those in the front row, but are generally set in such a manner that a spindle in the back row will come half way between two of the spindles in the front row, as shown in Fig. 6; this figure gives a view of five spindles, flyers, and bobbins

FIG. 5

as they would appear when looked at from above. It is customary to describe the gauge of the spindles, that is, the distance from the center of one spindle to the center of the next spindle in the same row, as so many inches; for instance, 6 inches, etc. Another method is to state the number of spindles in a certain number of inches; for instance, if the distance from the center of one spindle to the center of the next spindle in the same row is 6 inches, then the frame is spoken of as having 6 spindles in 18 inches, there being two rows of spindles and the spindles in each

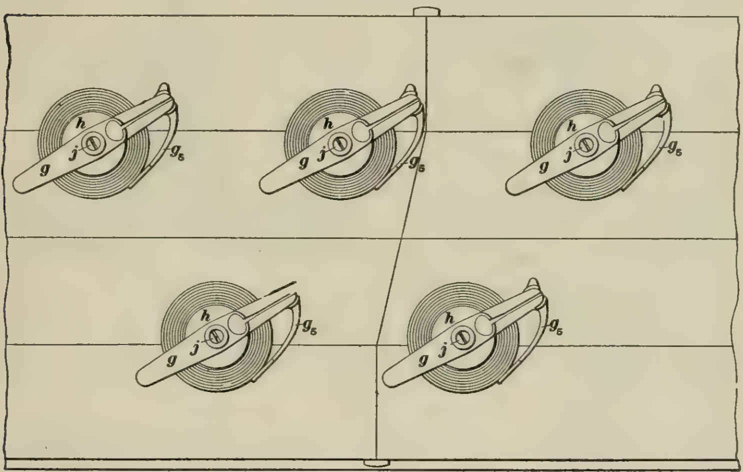


FIG. 6

row being spaced alike. The total number of spindles in a frame varies and is dependent on the gauge of the spindles and the length of the frame. Fly frames as a rule do not often exceed 36 feet in length, and are seldom built less than 20 feet in length.

7. The Footstep.—The **footstep bearing,** or **footstep,** j_2 in which the base of the spindle rests is shown in Figs. 3 and 7. These steps are bolted to the step rail j_3 that extends the entire length of the frame, very near the floor; a cross-section of the step rail is shown in Fig. 8. It

will be noticed that both sides of the rail are made alike and will thus allow the footsteps to be placed on each side; the two rows of spindles necessitate this arrangement. At frequent intervals along the step rail are set footsteps that carry a bearing for the spindle shafts p. The two spindle shafts, one for each row of spindles, carry gears p_2 that drive gears j_1 setscrewed to the spindles, and thus give the spindles their motion. The spindle shafts, spindle steps, step rails, and the gears both on the spindles and

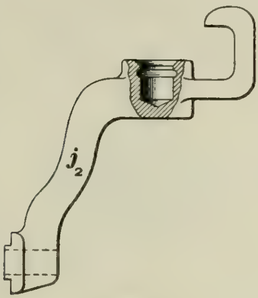


FIG. 7

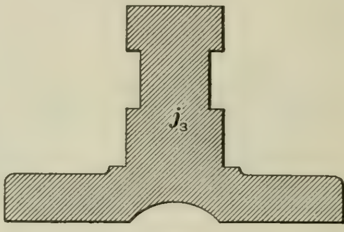


FIG. 8

on the spindle shafts are completely enclosed in order to prevent any dirt or loose cotton from collecting on the various parts.

8. The Bolster.—As the spindles are of considerable length, it is absolutely necessary that some bearing be provided for them in addition to the support formed by the step, in order to support them in a vertical position, and so that they may run true. This is accomplished by having a bolster, shown in Fig. 9, through which the upper part of the spindle projects. The bolster consists of a collar k, through which the spindle passes, the upper part being bored to such a diameter as will just fit the outside diameter of the spindle. At the lower part of the bolster is a shoulder k_1, that fits a recess in the bolster rail, to which it is firmly bolted. The bolster rail, a cross-section of which is shown in Fig. 10, is made alike on both sides, in order to provide for bolsters for each row of spindles.

At one time, the collars used to support the spindles vertically were rather short, not projecting much above the bolster rail, but it is now the universal custom to use long collars, such as that shown in Fig. 9. The advantage of the short collar was in being able to use a bobbin of less outside diameter and thus have more stock wound on it, as the shortness and small diameter of the collar did not require as great an opening, or hole, in the bobbin; consequently, allowing the outside diameter of the bobbin to be less in proportion. The disadvantage of the use of the short collar was due to the fact of its supporting the spindle at a point a considerable distance from its upper end, even when the bobbin rail was at its highest position. As the bobbin rail moved downwards this defect was accentuated,

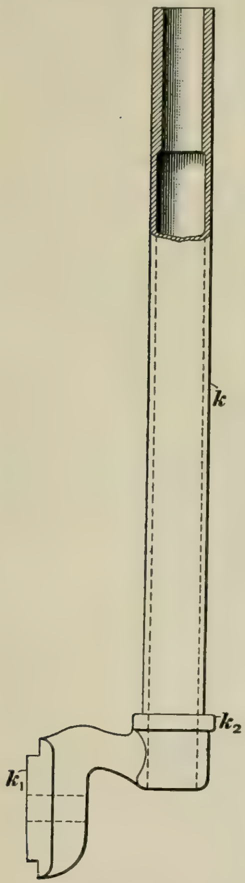


FIG. 9

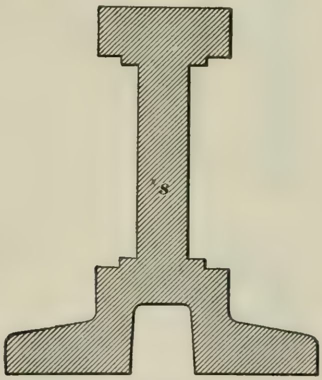


FIG. 10

and since the spindle and flyer ran at high speed and had no support at any point in the upper half of the length of the spindle, this tended to develop vibration and wear. In using such a collar as is shown in Fig. 9, the bearing part that supports the spindles is placed a considerable distance above

the bolster rail and several inches nearer the top of the spindle, which is conducive to steady running of the spindles. The spindle has a bearing only in the upper part of the collar, for about 2 inches, the lower part being bored out to a larger diameter than that of the spindle. This method of construction reduces the amount of friction that would take place should the spindle bear against the entire length of the collar.

9. The Bobbin.—Fig. 11 shows a cross-section of a long-collar bobbin used on fly frames. Such bobbins are usually constructed of wood, although sometimes made of paper or corrugated metal. The cheapest bobbins are those made of plain wood without any protection whatever, but it has been found an advantage to have the lower end of the bobbins protected by a wire placed in a groove, or even by a metal shield surrounding the base of the bobbin and partially embedded in it. The cost of a bobbin constructed in this manner

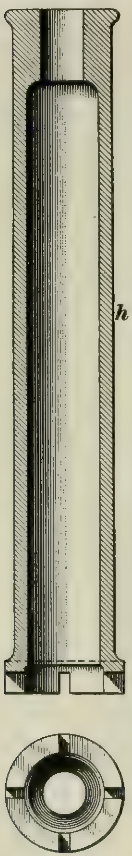


Fig. 11

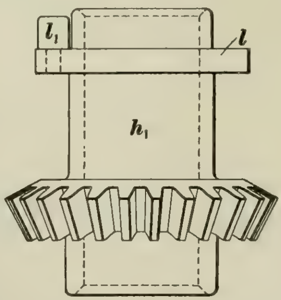


Fig. 12

is higher, but breakage and wear and tear of the bobbin are very much less.

When the bobbin is in position on the frame, the smaller hole at the top of the bobbin receives the spindle and the larger opening encloses the collar, which is thus entirely covered by the bobbin.

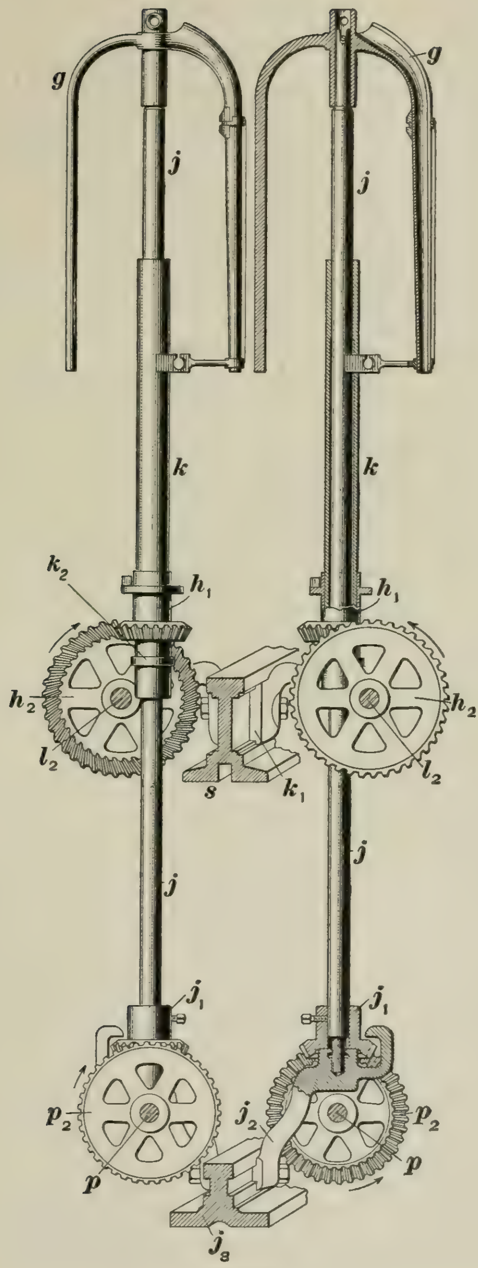


FIG. 13

The bobbin gear, shown in Fig. 12, rests on a projection k_2, Figs. 3 and 9, carried by the bolster. It is not fastened in any manner to the bolster and is thus free to revolve loosely around the long collar that furnishes a bearing for the spindle. Motion is imparted to the bobbin gear h_1 by means of a gear h_2 setscrewed to the bobbin shaft l_2, which is supported by bearings fastened to certain of the bolsters. As shown in Fig. 12, the bobbin gear carries a flange l on which the bobbin rests. A projection l_1 on this flange extends into one of several slots in the base of the bobbin, and thus drives the bobbin. In case long collars are used on bolsters, the collar extends for some distance into the bobbin, and it is very essential that the bobbins on any fly frame should be well constructed to exact dimensions, so as to grip the bobbin gear well and fit the spindle and collar as closely as possible without binding. Bobbin gauges are now made by several manufacturers of fly frames to test accurately the inside and outside diameters of a bobbin, and it is advisable to have a set of these gauges with which to test new bobbins before they are run.

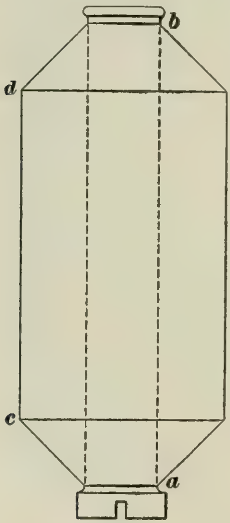


FIG. 14

The bobbin gears, the gears on the bobbin shafts, the bobbin shafts, the bobbin rail, and the lower ends of the bolsters are completely enclosed, in order to prevent as far as possible any fly or dirt from collecting on the various parts. Fig. 13 shows the connection between those parts of a fly frame that have been described, such as the footstep, spindle, bolster, bobbin rail, step rail, flyer, etc. It will be noticed that two rows of spindles are shown, many of the parts in one row being shown in section, while the parts in the other row are shown in full. By comparing this figure with those that show the different parts separate, a good idea will be obtained of the relative position of each part.

The manner in which the roving is built up on the bobbin is shown in Fig. 14. It is wound in close spirals around the empty bobbin until the entire length of the bobbin, with the exception of about $\frac{1}{2}$ inch at the top and 1 inch at the bottom, is covered; the complete length of roving that extends from the bottom to the top of the bobbin is known as a layer. It is the object to build up the bobbin with cone-shaped ends, as shown in Fig. 14; consequently, each succeeding layer on the bobbin must be a little shorter than the preceding one, this being continued until the distance *a b*, Fig. 14, is reduced to the distance *c d*.

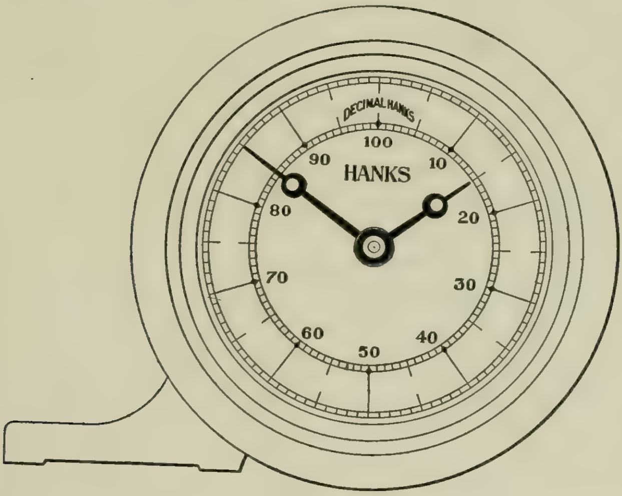


FIG. 15

10. Hank Clocks.—Fig. 15 shows an instrument known as a **hank clock,** which is attached to all fly frames. The object of the clock is to register the number of hanks of roving that pass the delivery rolls. This clock is usually situated at the foot end of the frame and has attached to it a worm-gear that is driven by a worm situated on the end of the front roll. By considering the diameter of the front roll and by having a suitable number of teeth in the worm-gear and the gears forming the clock, the exact length that passes the delivery rolls will be indicated on the hank clock, the

length, however, being expressed in hanks. This clock is read on the same principle as most clocks or indicators. The short hand indicates the number of hanks, while the long one indicates the fractions of a hank in one-hundredth parts.

METHOD OF INSERTING TWIST

11. It is necessary to insert a small number of turns per inch in the roving after it leaves the front drawing rolls, in order to enable the fibers to hold together and withstand the strain of being wound on the bobbin and unwound at the next process. In common with all cotton-yarn-preparation machines where twist is inserted in a strand of material, the strand is held at one point while it is revolved at another. Strictly speaking, the strand is also held at this point, but by a revolving mechanism. In fly frames, the roving is gripped between the bottom and top front rolls as it is being delivered, and is also held by the bobbin on which it is being wound, although as the roving passes through the hole in the boss of the flyer and down the hollow leg, the top of the boss of the flyer practically forms the termination of the grip of the roving at this point. Consequently, the roving may be considered as being firmly held here, and since the spindle and flyer are making from 600 to 1,400 revolutions per minute, the roving is being twisted all the time.

The rolls of course are constantly delivering roving and the bobbins taking it up as fast as it is delivered, so that while the roving that is being twisted at any one time is in a suitable position to receive the twist, a new supply is constantly being brought under the twisting operation, at a regular and uniform rate of speed, and that portion already twisted is passing from the influence of the twisting mechanism and on to the bobbin. In ascertaining the amount of twist per inch inserted in the roving, it is therefore necessary to obtain data as to the number of inches of roving delivered by the rolls during a certain period, and the number of turns made by the spindle during the same period.

If, for example, the flyer makes 25 revolutions while the rolls deliver $12\frac{1}{2}$ inches of roving, then there will be $25 \div 12\frac{1}{2} = 2$ complete turns put into an inch of the roving delivered.

WINDING THE ROVING ON THE BOBBIN

12. The front rolls of a fly frame rotate at a constant rate of speed while the machine is in motion; hence, a uniform length of roving is being constantly delivered. Suitable means must be provided for winding this roving on to the bobbin as fast as it is delivered, but at the same time the mechanism for winding must be such that the roving will not be broken or strained. As shown in Fig. 13, the flyer is supported by the spindle, which also imparts a rotary motion to it, while the bobbin, although placed on the spindle and rotating on the same center as the flyer, is driven by an entirely separate mechanism. The roving is wrapped around the bobbin because of the difference in the velocity of the bobbin and the flyer eye, since if both revolved in the same direction and at the same speed the roving could not be drawn through the eye of the flyer and wound around the bobbin. In considering the action of the flyer and bobbin in winding the roving about the latter, it will be found that there are several possible methods by which this may be accomplished.

1. A uniform rotary motion may be imparted to the flyer alone, the bobbin remaining stationary. This method, however, is not practicable, because as the roving is wound around the bobbin the diameter of the latter increases, and therefore a greater length of roving will be required for each successive revolution of the flyer; hence, if a uniform amount of roving is delivered by the drawing rolls the strain on it will quickly increase until sufficient to cause it to break. This difficulty might be remedied by uniformly decreasing the speed of the flyer as the diameter of the bobbin increases, but as the speed of the flyer governs the amount of twist in the roving, a variation in the turns per inch would ensue in this case.

2. A rotary motion may be given to both the flyer and the bobbin, the speed of the flyer being just sufficiently in excess of that of the bobbin to wind the roving on to the latter as fast as it is delivered by the drawing rolls of the frame. Since in this case the flyer is moving faster than

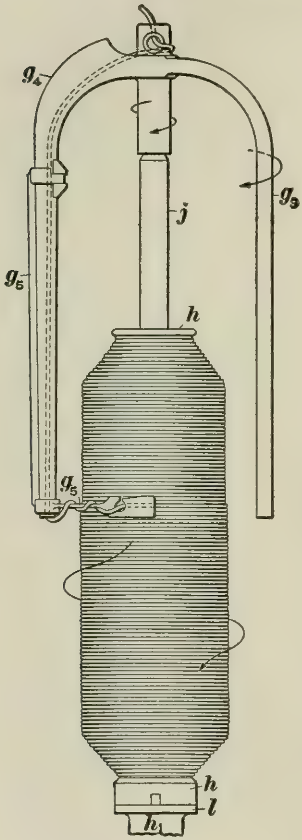


FIG. 16

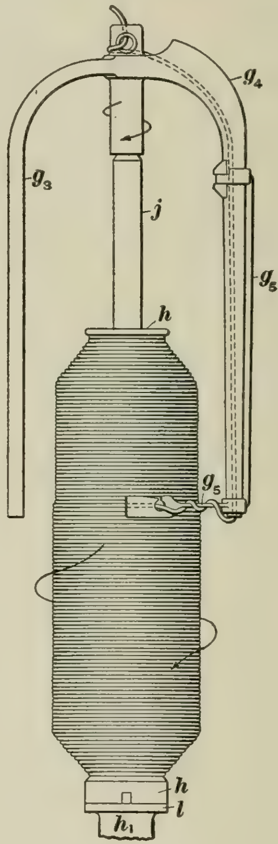


FIG. 17

the bobbin, or leading it, the arrangement is known as a *flyer lead*, and a frame thus equipped is called a *flyer-lead frame*. Fig. 16 illustrates the relative positions of the flyer, bobbin, and roving in a flyer-lead frame. In considering the

operation of this arrangement it will be remembered that in a given length of time the front drawing rolls of the frame deliver a definite length of roving. Assume, for the purpose of illustration, that this definite length is 6 inches. Then, in order to wind this length of roving on to the bobbin in a flyer-lead frame, the eye of the presser on the flyer must move just 6 inches farther than a point on the surface of the bobbin during the length of time that it takes for the drawing rolls to deliver 6 inches of roving. This gain, or lead, of the flyer over the bobbin is independent of the actual velocities of the flyer and bobbin, both of which are of course rapidly rotating in the same direction. Flyer-lead frames were formerly very popular, but are not used to a great extent at the present time.

3. There is another method of winding the roving on to the bobbin in which the bobbin rotates at a speed just sufficiently in excess of that of the flyer to cause it to wind on the roving as fast as it is delivered by the drawing rolls. This is the arrangement that is almost always adopted on modern fly frames, and since in this case the bobbin rotates faster, or leads the flyer, it is known as the *bobbin-lead method*, fly frames thus equipped being known as *bobbin-lead frames*. Fig. 17 shows the position assumed by the bobbin, flyer, and roving in a bobbin-lead fly frame. The front rolls always deliver a uniform length of roving in any given length of time, and for the purpose of illustration it may also be assumed in this case that the length delivered in a given period of time is 6 inches. Then, in order to wind this length of roving on to the bobbin in a bobbin-lead frame, a point on the surface of the bobbin must move just 6 inches farther than the eye of the flyer presser during the length of time that it takes for the drawing rolls to deliver 6 inches of roving. This gain, or lead, of the bobbin over the flyer is independent of the actual velocities of the bobbin and flyer, both of which are of course rotating rapidly in the same direction, as was the case in the flyer-lead frame, only in this case the bobbin has the greater speed.

13. In both flyer-lead and bobbin-lead fly frames, the speed of the delivery of the roving and the speed of the flyers are constant. This is necessary, because if the speed of the drawing rolls were made variable the production of the frame would be altered, and also because, in order to produce an even roving, the sliver should be drawn at a regular and uniform speed. A variable speed of the flyers is impracticable, because this would produce a variation in the amount of twist in the roving. In order, therefore, to compensate for the constantly increasing diameter of the bobbin, a variation must be made in its speed, so that the tension on the roving during the winding will be the same whether the bobbin is empty or full. If the bobbin did not increase in diameter as it filled with roving, the speeds of the flyer and bobbin could be easily regulated so that the exact amount of roving delivered would be taken up. The conditions are more difficult than this, however, because one revolution of a full bobbin requires a much greater length of roving to make one turn around the bobbin than does one revolution of an empty bobbin; in other words, the circumferential speed of the bobbin must be the same, no matter what its diameter is, whether full, empty, or in any intermediate condition. For example, suppose that the diameter of an empty bobbin is 2 inches and of a full one 4 inches; then in the first case only $2 \times 3.1416 = 6.2832$ inches of roving will be required to make one turn around the bobbin, while in the latter case $4 \times 3.1416 = 12.5664$ inches will be required to accomplish the same result. Thus, as the length of roving delivered is a constant quantity, and as the difference in the circumferential speed of the bobbin and of the flyer must also be constant, the speed of the bobbin must be constantly varied as the winding progresses.

In a flyer-lead frame, since the flyer rotates at a speed greater than that of the bobbin, the latter must have its slowest speed when empty and its greatest speed when filled, and must constantly and uniformly increase in the number of revolutions per minute between these two extremes. This is the principal objection to a flyer-lead

frame—the larger and heavier the bobbins become, the faster they must be driven, hence the greater the amount of power required to drive the machine.

In a bobbin-lead frame, however, since the speed of the bobbin is greater than that of the flyer the bobbin must rotate at its greatest speed when empty and at its slowest speed when full, and must constantly and uniformly decrease in the number of revolutions per minute between these two points. For this reason the bobbin-lead frame is preferred to the flyer-lead, since in this case as the bobbins grow large and heavy, it is not necessary to drive them so fast, and the consumption of power is therefore more uniform.

Although the mechanism for producing this variable speed of the bobbins is described later, it will be of advantage to note that with the introduction of cones it is possible, by making use of suitable gearing, to alter the speed of the bobbins.

14. Traverse of Bobbins.—It will be remembered that the lower end of the bolsters, the bolster rail, the bobbin shafts, and the toothed portion of the bobbin gears are completely enclosed. These parts combined form what is known as the carriage, which is given a vertical reciprocating motion in order to give the necessary traverse to the bobbins. As the bobbins are placed over the bolsters and rest on the bobbin gears, which form a part of the carriage, they receive a vertical reciprocating motion in addition to their rotary axial motion received from the bobbin gears. As the flyer eye continues to revolve in one plane during this traverse of the bobbin, the spindle rail being stationary, the roving is wound on the bobbin in coils, which vary in pitch according to the velocity of the vertical movement of the bobbin.

Fig. 3 illustrates one method of imparting the vertical motion to the carriage. The legs r support the various parts of the frame, their number varying according to the length of the frame. These legs are known as **sampsons**, and have on one face a groove in which a portion of a rack r_1 slides. As the rack r_1 has an up-and-down motion, the groove in the

sampson serves to steady and guide it in order that it may mesh properly with the gear r_2 setscrewed to the shaft r_3, which extends the entire length of the frame. The racks are connected to the carriage by means of arms r_4 securely bolted to the bolster rail s. As the gear r_2 revolves first in one direction and then in the other, the carriage is given a vertical reciprocating motion for a certain distance, which is regulated by the period of rotation of the gear r_2 in either direction. In addition to the steadying of the carriage by the racks, there is a slide connection between the head and foot sampsons and the corresponding ends of the bolster rail that helps to steady and guide it, and if properly adjusted insures a free and perfect motion of the carriage. As the carriage has considerable weight, it is balanced by suitable mechanism, the usual method being to hang weights by means of chains at each sampson. Referring to Fig. 3, the weight t is supported by means of a chain t_1 attached to a bracket, the chain passing around a pulley r_5 attached to the rack r_1 and also over pulleys t_3, t_2 attached to the sampson; the weight is arranged to balance the rail when the bobbins are half full.

Another method of balancing the carriage is shown in Fig. 18. Weights t are suspended from a chain t_1 that passes around pulleys t_2, t_3 and is attached to a drum r_5 on the shaft r_6, which carries a gear meshing with teeth in the lever r_4. The forward end of this lever bears directly against the under side of a small pulley carried by a bracket s_1 that is attached to the bolster rail s. This method prevents any possibility of the racks binding in the slides, which sometimes happens with the other method, unless a great deal of care is taken with the racks and slides.

The latest method of overcoming the weight of the carriage and bobbins is by means of a self-balanced carriage. With this motion the carriage is divided at the center of its length into two equal parts, and when one section is descending the other is ascending; consequently, one section counterbalances the other. The carriage is supported and guided by means of racks and pinions, as shown in Fig. 3, with the

exception of the weights. The racks r_1 for one section of the carriage face in the direction shown in Fig. 3, while the

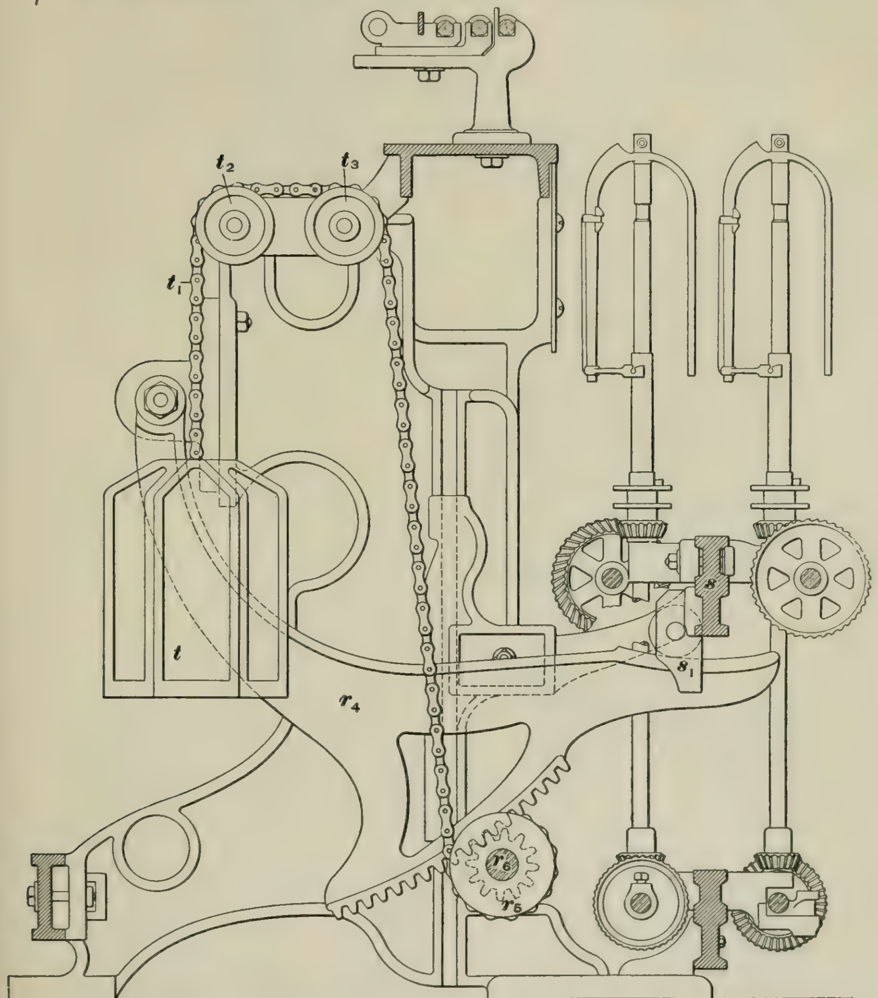


FIG. 18

racks for the other section face in the opposite direction; consequently, as the back shaft r_3 revolves, one section of

the carriage will ascend and the other descend, thereby balancing each other.

Since the carriage is divided into two parts, it is necessary to use a second mechanism in order to drive the bobbins of the second section. This mechanism is situated in about the center of the frame and is driven from the first by means of a long shaft that extends from the head of the frame to the second section. This shaft carries a gear at the head end that is driven from a gear placed on the sleeve between the gears h_5, h_6, Fig. 19. At the opposite end of this shaft is a gear that drives the second mechanism by means of a carrier gear. By adopting this last method, the carriage is accurately balanced at all times during the building of the bobbins, while with the other motions the carriage is only accurately balanced when the bobbins are half full.

The description of the method of reversing the direction of motion of the gear r_2, Fig. 3, and the different mechanical arrangements that are necessary in order to allow the carriage to rise and fall and still have the driving arrangement of the bobbin shafts intact, will be given in detail later.

GEARING

15. Method of Driving the Drawing Rolls.—Fig. 19 gives a diagrammatic view of the gearing for a slubber. The parts are not in all cases shown in the exact position that they occupy in the frame, since the method of gearing could not then be clearly indicated. On the shaft m, which is known as the **jack-shaft** and is the main driving shaft of the frame, are placed the tight-and-loose pulleys m_1, m_2, respectively, which are driven either from the line shaft of the room or from a countershaft belted to the line shaft. On the end of the jack-shaft m is a gear m_3, known as the **twist gear,** which through the intermediate gear m_4 and gear n_1 drives the top cone shaft n. This shaft carries at the head, or driving, end a gear n_2 that drives a gear f on the bottom front roll f_1. The method of driving the two back rolls from the front roll is shown in Fig. 19.

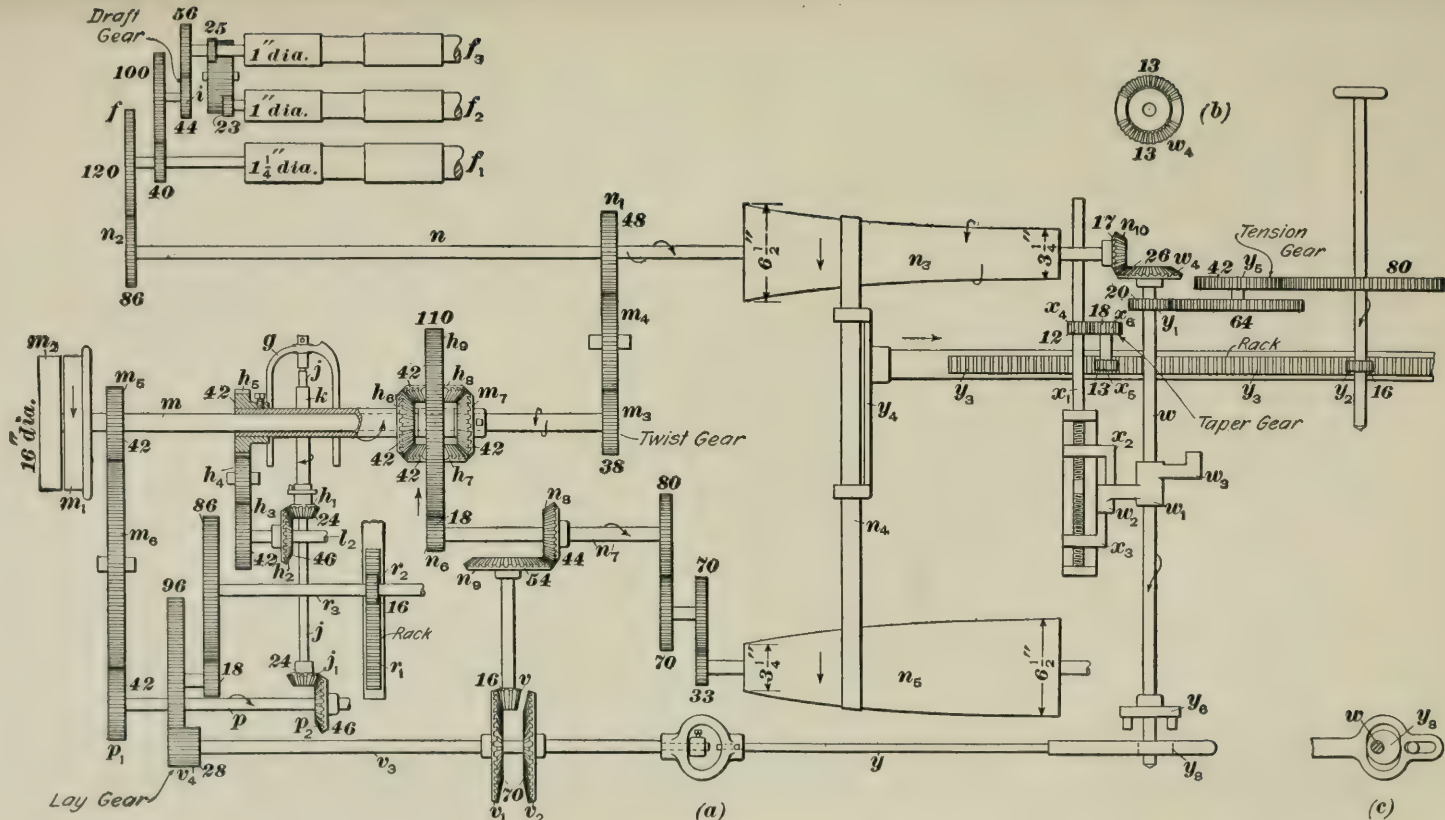

Draft Gear
Tension Gear
Taper Gear
Rack
Twist Gear
Lay Gear
(a)
(b)
(c)

FIG. 19

16. Method of Driving the Spindles.—On the end of the jack-shaft that carries the tight-and-loose pulleys is a gear m_5 that, through an intermediate, or carrier gear, m_6, drives a gear p_1 that is on the spindle shaft p. Gears on this shaft similar to p_2 drive the gears j_1 that are setscrewed to the spindles j. It will be remembered that there are two rows of spindles in all fly frames; consequently, there must be two spindle shafts similar to p. Only one shaft is shown in Fig. 19, as the two shafts are placed one directly behind the other. The one shown is the back spindle shaft, which always receives its motion direct from the jack-shaft of the frame. Gearing with the gear p_1 is a gear on the end of the front spindle shaft by which this shaft receives its motion.

An important point to be noted in this connection is that since the gear on one shaft is driven directly by a gear on the other shaft without the use of any intermediate gear, the two spindle shafts must revolve in opposite directions. If with this arrangement the gears on each spindle shaft were connected to the gears on the spindles that they drive in exactly the same manner, the two rows of spindles would revolve in opposite directions. In order to overcome this difficulty the gears on one spindle shaft are placed on one side of the gears on the spindles that they drive, while the gears on the other spindle shaft are placed on the opposite side of the gears on the spindles that they drive, as shown in Fig. 13.

17. Method of Driving the Bobbins.—Referring again to Fig. 19, it will be noticed that a gear m_7 is setscrewed to the jack-shaft. This gear through the gears h_7, h_8 drives the gear h_6, which is setscrewed to a sleeve that is loose on the jack-shaft. This sleeve carries another gear h_5, which through a carrier gear h_4 drives the gear h_3 on the back bobbin shaft l_2. The bobbin shaft carries bevel gears h_2 that drive the bobbin gears h_1. These bobbin gears are illustrated in Fig. 12 and carry a flange, a projection of which engages with a slot in the bottom of the bobbin and thus causes the bobbin to revolve with the bobbin gear. A gear on the front bobbin shaft is driven directly from the

gear h_3, Fig. 19, on the back bobbin shaft, and since these shafts revolve in opposite directions, it is necessary, in order to have all the bobbins revolve in the same direction, to place the gears on one bobbin shaft on one side of the bobbin gears that they drive, while the gears on the other bobbin shaft must be placed on the opposite side of the bobbin gears that they drive. This arrangement is also shown in Fig. 13.

DIMENSIONS OF FLY FRAMES

18. Fly frames are spoken of not only according to the name of each kind of frame, but also by the number of spindles, the length of the bobbin that the first layer of roving covers (known as the *traverse* of the bobbin), and the diameter of the full bobbin. Thus, a frame spoken of as a 96-spindle 9 in. $\times$ $4\frac{1}{2}$ in. indicates that the frame has two rows of spindles, 48 in each row; that the greatest possible traverse on the bobbin is 9 inches in length; and that when the bobbin is full it cannot exceed $4\frac{1}{2}$ inches in diameter. The traverse of a bobbin used on slubbers is usually from 10 to 12 inches; on first intermediates, from 8 to 10 inches; on second intermediates, from 7 to 8 inches; and on roving frames, from 5 to 6 inches. The reason for this gradual reduction in the traverse of the bobbin is that as the roving becomes reduced in size it is necessary to wind it on a smaller bobbin, so that the bobbin will not be too large to be pulled around by the roving when placed in the creel of the succeeding machine.

The diameter of the full bobbin that can be made depends on the distance between the spindles, which is so arranged as not to make too large a bobbin, for the same reason as that given above. In most cases the diameter of the full bobbin is one-half the length of the traverse; for example, a 12-inch traverse frame makes a 6-inch bobbin, usually written 12×6. Other sizes are referred to as 10×5, $9 \times 4\frac{1}{2}$, 8×4, $7 \times 3\frac{1}{2}$, 6×3, etc. There are exceptions to this rule in very fine frames, where the bobbin is often made smaller in diameter, as, for example, a $6 \times 2\frac{1}{2}$ frame. In this connection

it should be noted that the diameter of a full bobbin made on a fly frame is not equal to the space between two spindles in the same row. For example, on a 12 × 6 frame the space between the spindles in the same row is 10 inches, although the diameter of the full bobbin is only 6 inches. This allows sufficient space for clearance of the flyers while revolving.

The following table gives the standard sizes of frames as made by one machine builder:

TABLE I

Frame	Size Inches	Space Between Spindles Inches	Number of Spindles
Slubber	12 × 6	10	24 to 68
Slubber	12 × 6	9½	24 to 68
Slubber	11 × 5½	9	28 to 72
Slubber	10 × 5	9	32 to 76
Slubber	9 × 4½	7½	30 to 96
First intermediate	10 × 5	8	40 to 104
First intermediate	10 × 5	7½	42 to 108
First intermediate	9 × 4½	7	48 to 114
First intermediate	9 × 4½	6½	48 to 114
First intermediate	8 × 4	6	48 to 136
First intermediate	8 × 4	5⅞	48 to 136
First intermediate	8 × 4	5⅔	66 to 132
Second intermediate	8 × 3½	5¼	56 to 144
Second intermediate	7 × 3½	5¼	64 to 152
Second intermediate	7 × 3½	5	64 to 152
Second intermediate	7 × 3	4¾	72 to 160
Second intermediate	7 × 3	4½	72 to 160
Second intermediate	6 × 3	4½	80 to 168
Roving	6 × 2½	4¼	88 to 176
Roving	5 × 2½	4¼	96 to 184
Roving	4½ × 2¼	4	112 to 200

Fly frames are not usually constructed over 36 feet in length, as the torsion on the rolls and shafts would be excessive if this length were increased to any great extent. The modern tendency is to use frames of about this length, and Table I is prepared on this basis.

The main driving pulley, or the pulley on the jack-shaft, of the frame is usually about 16 inches in diameter with a 2-inch face, although pulleys are used that range from 12 to 16 inches in diameter, with faces from $1\frac{1}{2}$ to $2\frac{1}{2}$ inches in width.

The weights of the frames vary considerably according to the make, the number of spindles, and the gauge; a 72-spindle slubber will weigh about 7,800 pounds; a 120-spindle first intermediate will weigh about 10,750 pounds; a 144-spindle second intermediate, about 9,250 pounds; and a 200-spindle roving frame, about 9,780 pounds.

The horsepower required to drive a frame varies considerably; therefore, no table can be given that will be accurate under all conditions, as various matters affect the amount of power required. The following table may be used as a guide to determine the amount of horsepower required.

TABLE II

Frame	Gauge Inch	Spindles per Horsepower
Slubber	9	35
First intermediate .	7	60
Second intermediate	$5\frac{1}{4}$	75
Roving	$4\frac{1}{4}$	95

FLY FRAMES

(PART 2)

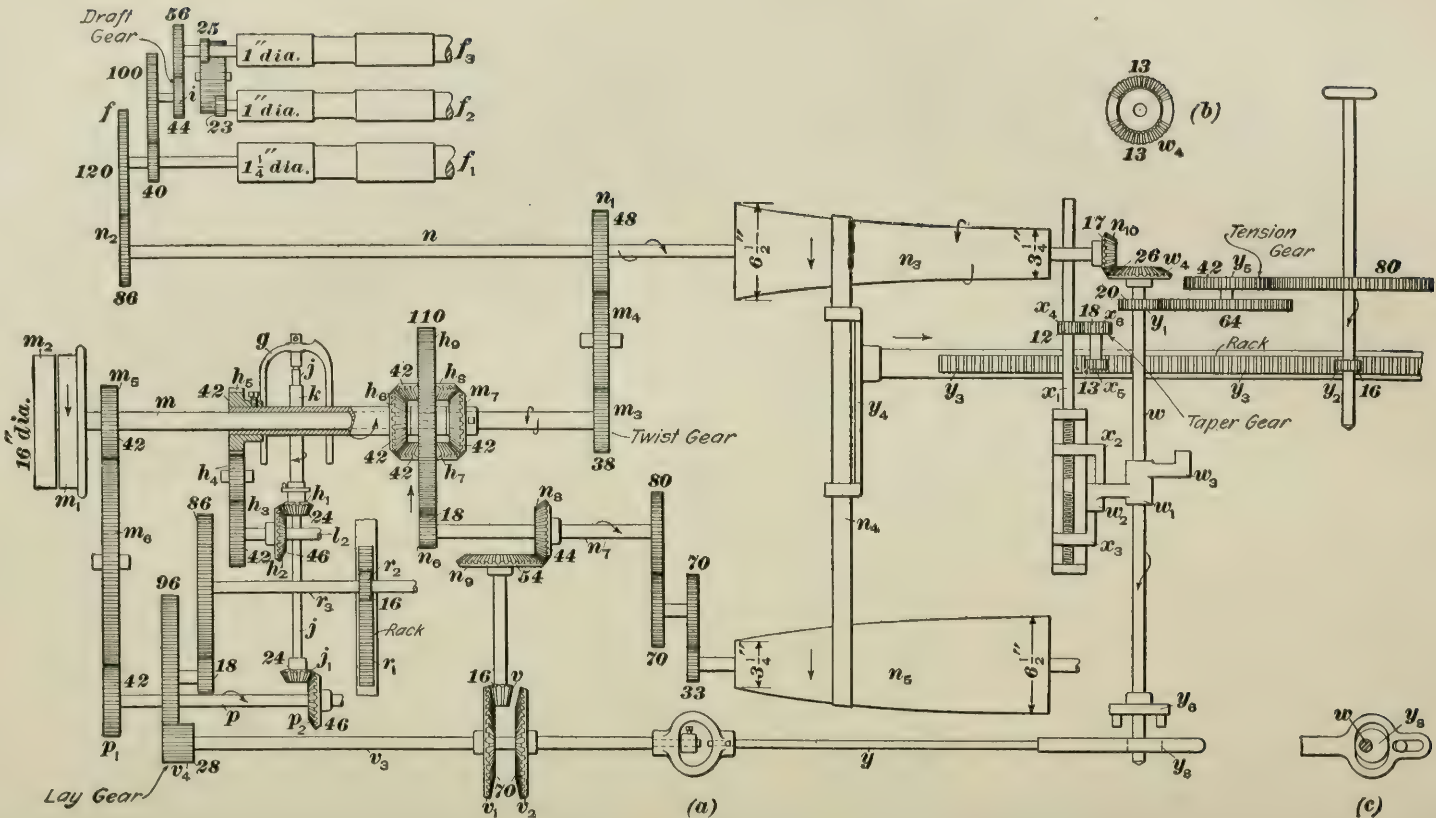
PRINCIPAL MOTIONS OF FLY FRAMES

MECHANISMS FOR CONTROLLING SPEED OF BOBBINS

DIFFERENTIAL MOTIONS

NOTE.—In this Section the bobbin-lead type of fly frames will be dealt with exclusively.

1. Introductory.—In order to wind the roving on the bobbin it is necessary that the excess circumferential speed of the bobbin over the flyer shall be equal to the circumferential speed of the front roll, so as to take up the roving as fast as it is delivered by the front roll. If the bobbin made the same number of revolutions per minute continually, it would gradually strain and break the roving as the bobbin increased in diameter; therefore, some arrangement must be adopted by which the number of revolutions per minute of the bobbin may be gradually reduced as the bobbin grows larger. The speed of the bobbin is regulated and controlled by two mechanisms that act in combination. One is known as the *differential motion*, more commonly called the *compound* in America, while the other consists of two cones and connections. The object is to provide a ready means of automatically reducing the number of revolutions per minute of the bobbin in exact proportion to the increase in its diameter.



Draft Gear
1" dia.
1" dia.
1¼" dia.
Tension Gear
Rack
Taper Gear
Twist Gear
Rack
16" dia.
Lay Gear
(a)
(b)
(c)

FIG. 1

2. Referring to Fig. 1, the gear m_7 on the jack-shaft drives the bobbins, its motion being imparted through the gears h_7, h_8 to the gear h_6, which is on a sleeve with h_5. The gear h_5 drives the bobbin shaft l_2 through the gears h_4, h_3, the bobbin receiving motion from this shaft by means of the gear h_2 and bobbin gear h_1. The speed of the gear m_7 is constant, but by a peculiar arrangement of the gears h_6, h_7, h_8, h_9 it is possible to alter the speed of the gear h_6 independently of m_7; this in turn alters the speed of the gear h_5 and consequently that of the bobbins. This alteration in the speed of the gear h_6 is obtained by imparting motion to the gear h_9 by an entirely independent mechanism. Dealing first with the method of driving the gear h_9, it will be noticed that the top cone shaft n carries a cone n_3 that, by means of a belt n_4, drives a bottom cone n_5. At the beginning of a set, that is, when the first layer of roving is being wound on the bobbins, the cone belt is at the large end of the top cone and at the small end of the bottom cone, but as the bobbins gradually grow larger the belt is moved along the cones, until at the finish of a set, that is, when the bobbins are full, the belt is at the small end of the top cone and the large end of the bottom cone. As the top cone is the driver, any parts receiving motion from the bottom cone will have their highest speed at the beginning of a set and their lowest speed at the finish. The manner in which the cone belt is moved along the cones as the bobbins are built will be fully explained later.

Referring again to Fig. 1, it will be noticed that a gear on the end of the bottom-cone shaft drives, through suitable gearing, the gear n_6, which meshes with the gear h_9; consequently, as the belt is moved from the small to the large end of the bottom cone, or, in other words, as the bobbins become full, the speed of the gear n_6 and therefore that of the gear h_9 will be lessened. The gears h_6, h_7, h_8, h_9, m_7 form the **compound, or differential motion,** and in order that the effect of lessening the speed of the gear n_6 may be fully understood, reference will now be made to Fig. 2, which is a view of the compound alone. The large gear h_9 is known as the *sun gear* and supports the two bevel gears h_7, h_8 by means

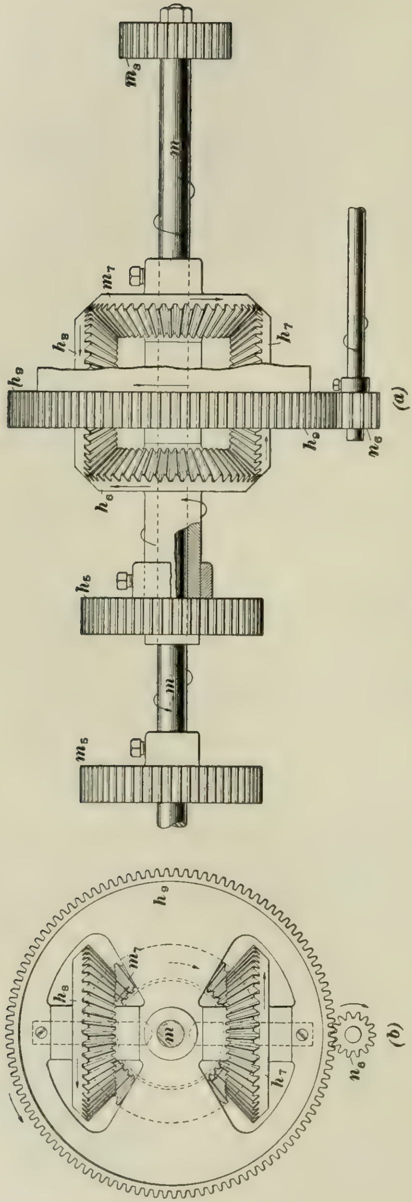


FIG. 2

of studs on which these gears work loosely, as shown in Fig. 2 (*b*). Thus, if the gear h_9 revolves it carries with it the two bevel gears h_7, h_8, which at the same time are free to revolve on the studs on which they are mounted. The action of these gears is as follows: The gear m_7 being fixed to the jack-shaft m drives the gear h_6 through the intermediate gears h_7, h_8. The gear h_7 performs the same work as h_8 and for present consideration may be imagined as not existing, being used merely to balance h_8 and cause the whole arrangement to revolve more uniformly. The gears m_7, h_6 are of the same size, and consequently if h_9 were held still, or prevented from revolving, m_7 would drive h_6 at the same speed as the shaft m, but in the opposite direction. If, however, h_9 is made to revolve in the same direction as h_6, the latter

makes not only the number of revolutions that it derives through being driven by m_7, but an additional number of revolutions caused by the acceleration that h_9 gives it.

3. One not acquainted with mechanics may be surprised that h_9 causes h_6 to be accelerated 2 revolutions for each revolution that h_9 makes. Since, however, this is a well-known fact, no mathematical proof will be given, but if the privilege of experimenting with a compound in a mill can be obtained it can easily be proved that by holding m_7 still and turning h_9 around once h_6 will revolve twice. Another test may be made with an ordinary yarn wrapping reel, in which a similar contrivance is used. It will be found that the reel makes two revolutions when the handle is turned once, although each of the gears that form the compound has the same number of teeth; the handle of the reel acts the same as gear h_9, Fig. 2.

To take an actual example, suppose that the jack-shaft m makes 400 revolutions per minute. If h_9 is held still, h_6 will make just 400 revolutions per minute, but in the opposite direction to m_7. Supposing that h_9 is now caused to revolve 20 times per minute in the same direction as h_6, it will be found that h_6 makes 440 revolutions per minute, since $400 + (20 \times 2) = 440$. Suppose that without stopping the frame, the number of revolutions of h_9 is automatically reduced to 15; then it will be found that h_6 makes 430 revolutions; thus, $400 + (15 \times 2) = 430$. Suppose, again, that the speed of h_9 is decreased to 10 revolutions per minute; then h_6 will make 420 revolutions, but always in the opposite direction to m_7; thus, $400 + (10 \times 2) = 420$. If the train of gears between the gear h_5 and the bobbins is so arranged that the bobbins make $2\frac{1}{2}$ times as many revolutions as the gear h_5, which is on the same sleeve as h_6, then in the first case the bobbins will make $440 \times 2\frac{1}{2} = 1{,}100$ revolutions, while in the last case they will make 1,050 revolutions, so that it will be seen that their speed has been automatically reduced from 1,100 to 1,050 revolutions per minute as the bobbin has increased in size.

It will thus be seen that this arrangement provides the varying conditions necessary for the building of a bobbin. When the roving is being wound on an empty bobbin, the latter must be rotated at its highest speed in order to wind on the roving delivered; this speed is attained by having the cone belt at the large end of the driving cone and the small end of the driven cone. As the roving is wound on the bobbin and the bobbin increases in size, a gradual reduction of the speed of the bobbin is required, so that it may revolve at its slowest speed when the bobbin is full. By this time the cone belt has been moved along the cones until the small end of the driving cone is driving the large end of the driven cone. As the speed of the driven cone gradually diminishes, that of the gear n_6 decreases also, since it is driven from the bottom cone. Consequently, the gear h_9 will be driven more slowly, as well as the gear h_6 and the gears that drive the bobbins, since these are driven from the gear h_5, which is on the same sleeve as the gear h_6.

4. The compound just described is an old type and is found on most of the older frames. The one great objection to it is the unnecessary strain on the cone belt on account of the friction caused by the sleeve that carries the gears h_6, h_5, and also the one that carries the sun gear h_9. These sleeves and gears revolve in an opposite direction to that of the jack-shaft m. The compounds shown in Figs. 3, 4, and 5 are built to avoid this fault and are so constructed that all parts revolve in the same direction. Although these styles differ in construction, they all have the same objects in general; that is, they are all constructed to drive the bobbins at a varying speed in order to effect winding, and in the last three types are constructed to reduce the strain on the cone belt by reducing the amount of friction and thereby reducing the liability of its breaking. The amount of oil consumed is also reduced to a minimum. As far as possible, the parts in Figs. 2, 3, 4, and 5 that perform similar work have the same reference letters.

Fig. 3 shows a compound that is peculiar in construction but very simple and accurate in its workings. On the main

shaft m is a boss, or cross-piece, q for the reception of, and to form a bearing for, the small cross-shaft q_1 that carries the two bevel gears h_7, h_8. Loose on the shaft m is a bell, or, as it is sometimes called, socket, gear h_5, which through its connections drives the bobbins. Attached to the gear h_5 is a bevel gear h_6. Beyond the cross-shaft and fast on a sleeve is the gear h_9, which is driven from the bottom cone by a train of gears. On the opposite end of this sleeve, which is loose on the shaft m, is a bevel gear m_7 that meshes with the larger bevel gear h_8. The shaft m being positively driven at a constant speed, imparts motion to the bell gear h_5, since the cross-shaft q_1 and the parts connected with it turn the bevel gear h_6 of which h_5 is a part, and if it were not for the additional speed imparted through the gear h_9,

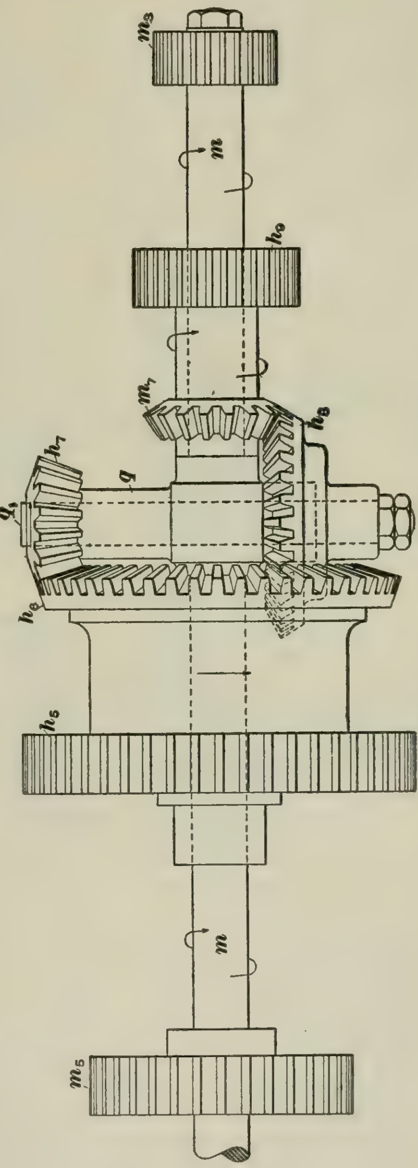


FIG. 3

the gear h_5 would make the same number of revolutions as m; h_9, however, is positively driven in the same direction as m through the cones, while m_7, being on the same sleeve with h_9, drives h_8 and consequently h_7 on the other end of the cross-shaft. As h_7 meshes with h_6, the latter and also h_5 receive an accelerated motion in addition to that derived through the motion of the shaft m.

The effect of the combined forces acting on h_5 is to cause it to revolve at such an accelerated speed that, when winding is being performed at the beginning of a set of bobbins, the empty bobbins revolve so much faster than the spindles as to wind on the roving delivered by the rolls. As the gear h_9 is driven from the bottom cone and the speed of this cone is reduced in the usual manner, the speed of h_9 is gradually reduced as the bobbins are built up, resulting in the diminishing of the speed of h_6 and h_5; the speed of these gears, however, is not reduced at any time so as to be less than the speed of the shaft m, thus always insuring that the bobbins revolve faster than the spindles and that winding is constantly taking place.

In this compound, all the gears that are loose on the shaft m revolve in the same direction as the shaft; thus, the power required to drive them is greatly reduced in comparison with the old-style compound, since there is only a very slight amount of friction between the gears and the shaft. An advantage over the older form of compound will be readily seen in the saving of power and the lessening of the strain on the working parts, especially on the cone belt, where the strain is lessened to a very great degree. In this compound, the revolution of the shaft m becomes a help to the cone belt instead of an obstacle, as in the old form of compound. The greatest strain put on the belt is no more than is required to revolve the bobbins at their maximum speed of about 100 revolutions per minute beyond those run by the spindles. The shaft helps to the extent of the number of revolutions that it drives the spindles, and the balance, which varies from 100 revolutions to none, is easily obtained with little strain on the cone belt. It is obvious that with

the strain thus reduced, the cone belt will almost entirely cease to be a trouble or the cause of bad work.

5. Fig. 4 (*a*) and (*b*) shows views of a compound widely different from those described. It uses spur gears instead of bevel gears, thus reducing the amount of friction. The gear h_9 is on a sleeve that carries at its opposite end a gear m_7; this sleeve is loose on the jack-shaft m and revolves in the same direction. The gear h_9 is driven by the cones

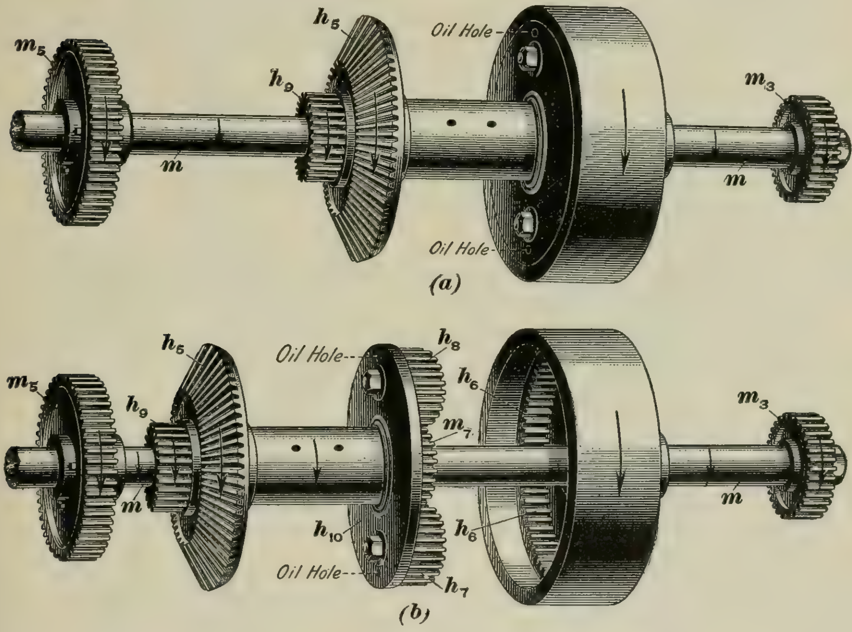
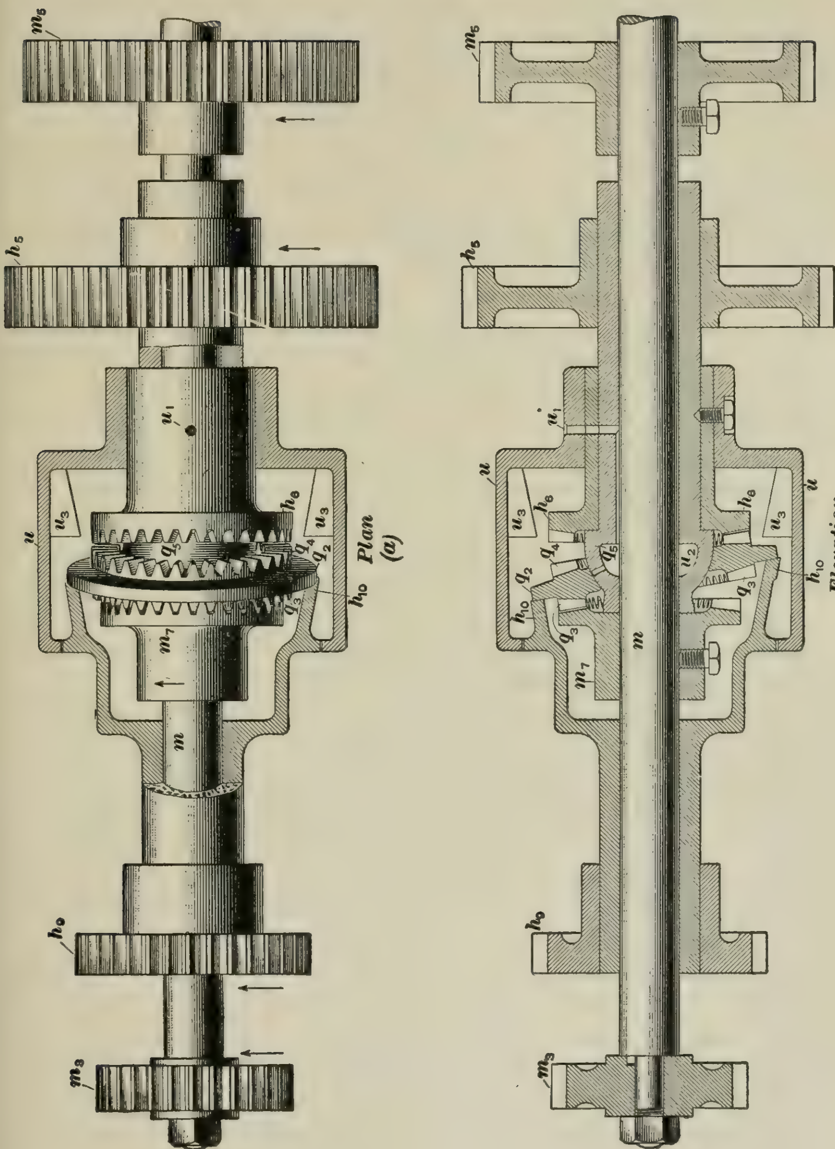


FIG. 4

in the usual manner, its speed depending on the position of the belt on the cones, while the gear m_7 causes the gears h_7, h_8 to revolve on their axes. The annular gear h_6, which is fast to the jack-shaft m and revolves with it, gives motion to the disk h_{10} simply because the gears h_7, h_8, which are on studs fastened to the disk, mesh with its teeth. The gears h_7, h_8 have two motions; they revolve on their axes and also around the annular gear h_6. Thus, the disk h_{10} is caused

to revolve at a greater speed than the jack-shaft, and as it is on the same sleeve as the gear h_5, it causes h_5 to revolve and give motion to the bobbins. When the speed of the gear h_9 is reduced by the cones, it reduces the speed of the gear m_7, and consequently that of the gears h_7, h_8, as well as that of the gear h_5, thus driving the bobbins more slowly. The sleeve that carries the gear h_5 and the disk h_{10} is outside of the one that carries the gears h_9, m_7, but it revolves in the same direction; thus there is a sleeve within a sleeve, forming what might be called a *double*, or *compound, sleeve*. The gearing in this compound is protected from dust and dirt by a shell or casing, which also forms an oil chamber so that the gears and sleeves are well lubricated at all times. Fig. 4 (*a*) shows the compound closed and in working position, while Fig. 4 (*b*) shows it open with the internal parts exposed to view.

6. A compound that is novel, compact, and very effective is shown in Fig. 5 (*a*) and (*b*); (*a*) is a plan view partly in section, while (*b*) is a sectional elevation. The jack-shaft m carries the twist gear m_3 and the spindle gear m_5, while the compound is situated between these two gears. Loose on the jack-shaft is a sleeve carrying the gear h_9 and the cam h_{10}. The cam is circular and has a beveled face, as shown in the elevation (*b*). Inside the shell, or bell, portion of the cam is the bevel gear m_7 fast to the jack-shaft m. Bearing against the face of the cam h_{10} is a circular disk q_2 that revolves freely on a spherical bearing q_5. This disk has 36 teeth on each side, as shown at q_3 and q_4; q_3 meshes with m_7, which has 32 teeth, while q_4 meshes with the bevel gear h_6, which has 36 teeth and is fastened to a long sleeve that is loose on the jack-shaft and carries the spherical bearing q_5 and the gear h_5 that drives the bobbins. As the jack-shaft revolves, it carries the bevel gear m_7 with it; and as m_7 meshes with q_3, it causes the circular disk to revolve on the spherical bearing. Since q_4 forms a part of the circular disk, it will revolve with the disk and impart motion to the bevel gear h_6 and the bobbin gear h_5, because q_4 meshes with h_6.



Plan
(a)

Elevation
(b)

FIG. 5

At the beginning of a new set of bobbins, the bobbin gear h_5 makes the same number of revolutions per minute as the jack-shaft, and drives the bobbins at the required speed to wind on the correct amount of roving. As the gear h_9 is driven from the cones, it is the only medium for altering the speed of the bobbins. When commencing to wind a new set of bobbins, this gear makes the same number of revolutions per minute as the jack-shaft; consequently, for the present the cam may be considered as not existing, as it maintains the same relation between the gears m_7, q_3, q_4, h_6, thus allowing them to act as clutch gears, because the same teeth of the gears mesh with each other for the time being, and cause h_5 to make the same number of revolutions as the jack-shaft.

At the completion of each layer of roving on the bobbins, the cone belt is moved along the cones, thereby decreasing the speed of the gear h_9 and the cam h_{10}. As the speed of the cam is decreased, it causes the circular disk to oscillate on the spherical bearing and change the points of contact of the gear m_7 with q_3, and q_4 with h_6. This oscillating motion of the disk causes q_3 to roll around the gear m_7, and as m_7 is smaller than q_3, it causes a direct loss of speed to the circular disk, because it requires more than one revolution of the gear m_7 to give q_3 one complete turn. Since the speed of the disk is reduced, the gears h_6, h_5 are affected in a similar manner, which causes the bobbins to make fewer revolutions per minute. The gradual reduction in the speed of the bobbins in a bobbin-lead frame is necessary in order that the bobbins may retain their proper circumferential speed, as their diameters increase with each new layer of roving.

This entire motion is protected by a shell, or casing, u and may be thoroughly oiled by means of the oil hole u_1, which extends through the boss of the casing and the sleeve of the spherical bearing to the jack-shaft, and there connects with a passage in the sleeve of the spherical bearing. This passage ends at a chamber u_2 that is in the spherical bearing. A hole in the bearing allows the oil to be distributed on the

face of the bearing and to pass into the large chamber, where it is distributed by the projections u_3 on all of the remaining parts, thus insuring a perfect lubrication at all times.

THE CONES

7. Any one of the four types of compounds described provides a method of controlling the speed of the bobbins and gradually reducing it as they increase in diameter, if the speed of the controlling gear of the compound itself is suitably reduced. The action of the compounds shown in Figs. 2, 3, 4, and 5 is governed by the gears lettered h_9 in each case. If in any one of these compounds the speed of this gear is reduced, the speed of the bobbins is reduced. To secure the suitable reduction of the speed of the controlling gear in compounds on fly frames, a pair of cones is always introduced between the source of power applied to the machine and the compounds. These cones as used in combination with the ordinary type of compound are shown in Fig. 1; the top cone n_3 is concave and has a diameter of $6\frac{1}{2}$ inches at one end and $3\frac{1}{4}$ at the other, while the lower cone is convex and has a diameter of $6\frac{1}{2}$ inches at the large end and $3\frac{1}{4}$ at the small end. These cones are connected by a belt, by which the upper cone drives the lower cone; this belt is gradually moved from the larger end of the top cone to the smaller end during the filling of the bobbin, a slight movement being given to it each time that the traverse of the frame is changed. This movement is so proportioned as to bring the cone belt to the small end of the upper cone by the time the bobbins are filled.

As the length of roving wound on the bobbin always equals the excess surface speed of the bobbin over the flyer, if a bobbin starts with a certain number of revolutions per minute, its rotary movement in excess of that of the flyer must be decreased in direct proportion to its increase in diameter. If the diameter of the full bobbin is four times that of the empty one, which is common in fly frames, the excess speed must be reduced to one-quarter. For instance,

if the empty bobbin is 1 inch in diameter and the full bobbin 4 inches in diameter, this means that the diameters of the cones must be arranged to give a reduction of 4 from one extreme to the other. The diameters suitable for this and such as are generally adopted are those mentioned, and it is obvious that the lower cone will revolve four times as fast when driven from the large end of the upper cone as it will when driven from the small end; thus, $6\frac{1}{2} \div 3\frac{1}{4} = 2$; $3\frac{1}{4} \div 6\frac{1}{2} = .5$; $2 \div .5 = 4$.

Formerly cones were made with a straight surface, diminishing equally from the large to the smaller end of the cone, but it has been found in practice that a concave upper cone and a convex bottom cone give more even winding, and they are now usually so constructed. When the belt is on the large end of the top cone and driving the small end of the bottom cone, the roving is being wound on the bare bobbin.

BUILDER MOTIONS

8. There are several very important points that should be considered in connection with the winding of the roving on the bobbin. It is customary to have each succeeding layer of roving slightly shorter than the preceding one, thus forming a taper at both ends of the bobbin. Thus, as is shown in Fig. 6, the first layer of roving that is placed on the bobbin extends from *a* to *b*, while the last layer extends only from *c* to *d*. Consequently, it becomes necessary to introduce some mechanism by means of which the traverse of the carriage may be shortened each time one complete layer of roving has been placed on the bobbin. It might naturally be supposed that since the traverse is shortened as the bobbin grows larger, the time occupied by the carriage in making the traverse will be lessened; but this is not so, since with each layer of roving the diameter of the bobbin is increased and consequently, although the part of the bobbin that is covered by the layer is less, there is actually a greater length of roving. Still another point to be noted is that in order to make a well-wound bobbin it is necessary that there should

be only a slight space between any two adjacent coils in the same layer of roving, and that this space should be maintained throughout the building of the bobbin. It will be seen that the distance between two adjacent coils of roving will depend on the speed at which the bobbin is traversed.

It would be a comparatively simple matter to so regulate the speed of the carriage that the roving would be wound correctly for one layer, but the principal difficulty in building the bobbin lies in the fact that the correct speed of the carriage for an empty bobbin is not the correct speed for the bobbin after it has had several layers of roving wound on it. That this is so may be readily seen if it is considered that with each additional layer of roving the bobbin is increased slightly in diameter and that consequently it takes a greater length of roving to form one complete coil around the bobbin. Therefore, in order that the same space may exist between two consecutive coils in any layer throughout the filling of the bobbin, the speed at which the carriage, and consequently the bobbin, traverses up and down must be lessened as the bobbin becomes larger.

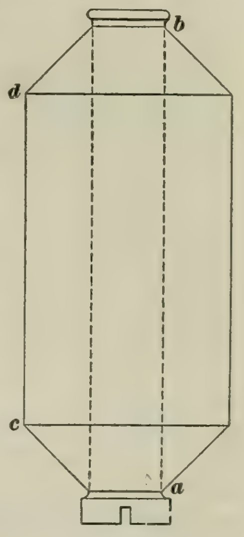


FIG. 6

Referring again to Fig. 1, the shaft n_7, which is driven from the bottom cone, carries a bevel gear n_8 that drives the bevel gear n_9 on an upright shaft. At the lower end of this upright shaft is a bevel gear v that by means of the gears v_1, v_2, the action of which will be explained later, gives motion to the shaft v_3. The gear v_4 on the end of this shaft drives, through suitable gearing, the shaft r_3, which carries the gear r_2 that imparts motion to the rack r_1. Since the motion of this train of gears is derived from the bottom cone, the rack and, consequently, the carriage will be driven at a speed that is uniformly decreasing as the bobbins are becoming full, which is the result desired.

AMERICAN TYPE OF BUILDER

9. In order to shorten the length of the traverse with each layer of roving placed on the bobbin and also to reverse the direction of the traverse, the **builder motion** is applied to all fly frames. A view of a builder motion that illustrates the style generally used on American-built frames is given in Figs. 1 and 7. Its parts are as follows: Attached to the carriage, and consequently rising and falling together with it, is a bracket x, Fig. 7, carrying a casting that supports a central shaft x_1 on which right- and left-hand threads are cut. The upper thread carries the jaw x_2, and the lower thread the jaw x_3; therefore, by turning the shaft x_1 in the proper direction the two jaws can be brought closer together, the upper jaw x_2 projecting beyond the lower jaw x_3 and being capable of sliding outside, as shown in the illustrations. The upper part of the shaft x_1 is made square and projects through a gear x_4 supported by a bracket. As the gear x_4 is not setscrewed to the shaft x_1, any vertical movement of one will not affect the other, and yet on account of that part of the shaft that projects through the gear being square, and the aperture in the gear being of such a shape as to fit the shaft, any rotary motion of one will be communicated to the other. In studying this motion it should be understood that as the bracket x is raised and lowered by the carriage it takes with it the shaft x_1 and the jaws x_2, x_3. Another upright shaft w, known as the **tumbler shaft,** carries a dog w_1 having two arms w_2, w_3. At the bottom of the tumbler shaft is a circular disk y_6 with two lugs, shown in plan in Fig. 7 (b), against each of which, in turn, a lever y_7 is pressed by means of a strong spring in such a manner as to tend to move the shaft a small portion of a revolution. At the upper end of the shaft is a gear w_4 composed of four sections, also shown in plan in Fig. 1 (b); two of these sections that are directly opposite each other have 13 teeth each, while the other two sections are blank.

10. The action of this part of the mechanism is as follows: Suppose that the parts are in the position shown in Fig. 7; then

the spring acting on one of the lugs on the disk at the foot of the shaft w is tending to give this shaft a partial revolu-

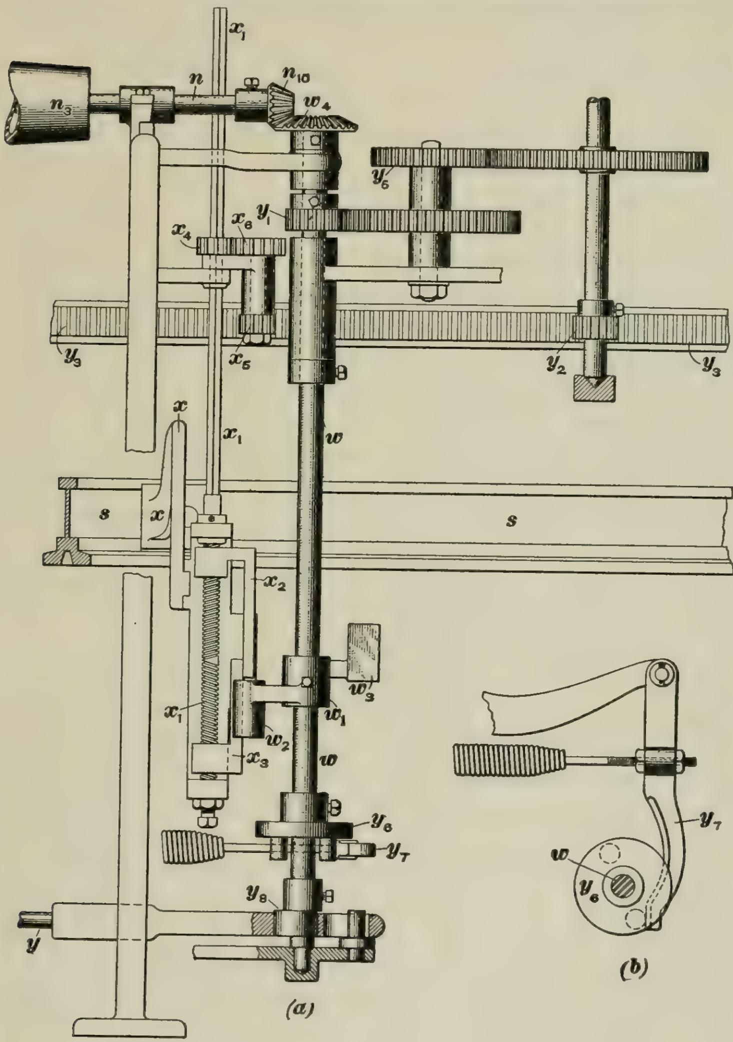


FIG. 7

tion but is prevented from doing so by the arm w_2 bearing against the jaw x_3. The carriage when the parts are in this

position is moving up, and when it has risen sufficiently so that the jaw x_3 is raised above the arm w_2, the spring is allowed to act on the shaft w and turn it until the gear n_{10} on the end of the top-cone shaft engages with the teeth in one of the sections of the gear w_4. These two gears continue to engage until a blank section on the gear w_4 is presented to n_{10}, at which point the spring at the foot of the shaft w will act on the second lug and further turn the shaft until the arm w_3 comes in contact with one of the jaws. The entire motion of the shaft w at any one time is thus equal to half a revolution. It should be noted that although the carriage at the time these actions take place is sufficiently high to allow the arm w_2 to pass under the jaw x_3, the arm w_3, owing to its being situated in a higher plane than w_2, will come in contact with the jaw x_3, and as the carriage is lowered, with the jaw x_2 also. When the motion of the carriage is downwards, the arm w_3 is bearing against the jaws, and as the jaw x_2 is brought low enough to free this arm the shaft w is given a half revolution in the same manner as that described.

In making this half revolution, the tumbler shaft accomplishes a change in three parts of the frame at the same time: (1) The carriage is driven in an opposite direction, that is, if it was going up before, it is going down after the shaft has turned; (2) the belt is moved along the cones for a short distance; (3) the length of the traverse is shortened. Dealing with these points separately and in the order given above, when the tumbler shaft is given a half revolution it turns the cam y_8 situated at its lower end, a plan view of which is shown in Fig. 1 (c). This action results in giving the rod y, Fig. 1, a longitudinal motion. This rod is jointed to the rod v_3 in such a manner that the latter is allowed to revolve without in any way affecting the former, and yet any longitudinal motion of one will affect the other. On the rod v_3 are shown two gears v_1, v_2, the teeth of which face each other; these are known as the **twin gears.** They are so adjusted on the rod that a movement in either direction of the rod y causes one or the other of the two gears to come in contact with the bevel gear v. It will be

seen that the direction in which the shaft v_3 rotates will be periodically reversed; i. e., if it were turning from right to left before the tumbler shaft turned, it will be turning from left to right afterwards. As the carriage is primarily driven by the shaft v_3, the direction of movement of the carriage will thus be reversed at every turn of the tumbler shaft.

On the tumbler shaft is placed a gear y_1 that through a suitable train drives the gear y_2 gearing into the rack y_3, which carries at one end a belt guide y_4, Fig. 1; consequently, as the tumbler shaft is revolved, the gear y_1 will turn y_2, thus giving motion to the rack y_3 and through the belt guide y_4 moving the belt a short distance toward the small end of the top cone.

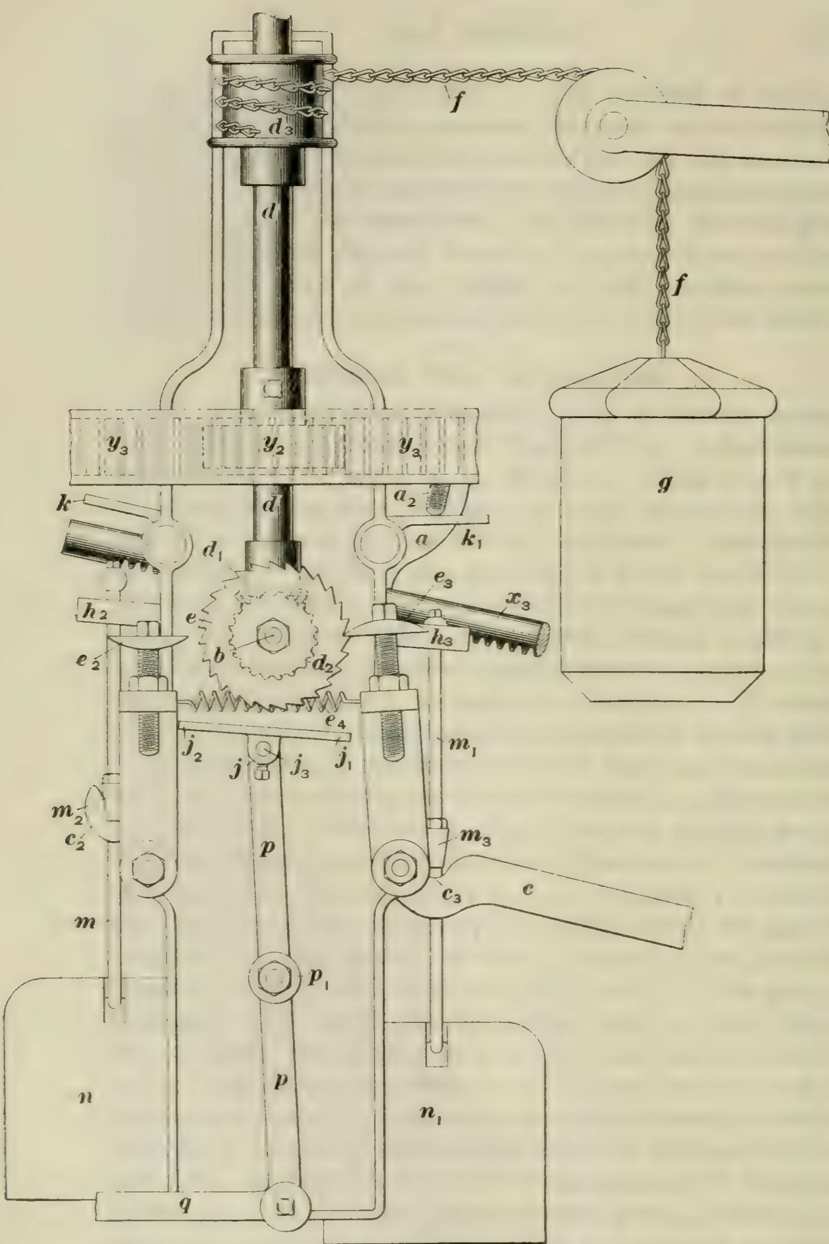
As the rack is moved, it imparts motion to the gear x_5 which through the gear x_6 turns the gear x_4 and consequently the shaft x_1. The movement of the shaft x_1 brings the jaws x_2, x_3 closer together, which allows the arms w_2, w_3 to escape the jaws when the carriage has made a shorter traverse than was previously necessary.

11. Change Gears.—In connection with this builder motion there are the following very important change gears, reference being made to Fig. 1: the lay gear v_4, the tension gear y_5, the taper gear x_6, and the rack gear y_2. The *lay gear* v_4 forms part of the train of gears that regulate the speed at which the carriage moves up and down, and consequently the distance between any two consecutive coils of roving on the bobbin. In case the correct distance is not maintained between the coils, this gear is the one that is changed. The *tension gear* y_5 regulates the distance that the cone belt moves along the cones at each reversal of the traverse of the carriage, and consequently controls the tension of the roving between the delivery rolls and the flyer, since if the belt is moved a shorter distance along the cones, it causes all the motions controlled by the cone belt to tend toward winding more quickly and thus increase the tension of the roving, while on the other hand if the cone belt is moved a greater distance, the reverse will be true. The *taper gear* x_6 regulates the distance that the jaws of the builder motion will

be brought toward each other at each reversal of the carriage, and consequently regulates the taper on the bobbin. The *rack gear* y_2 regulates the distance that the rack moves at any one time, and consequently also regulates both the tension and the taper at the same time. By changing the rack gear to a smaller gear the rack is moved a shorter distance, thus causing the jaws of the builder to come together more slowly and the belt to be moved along the cones more slowly.

ENGLISH TYPE OF BUILDER

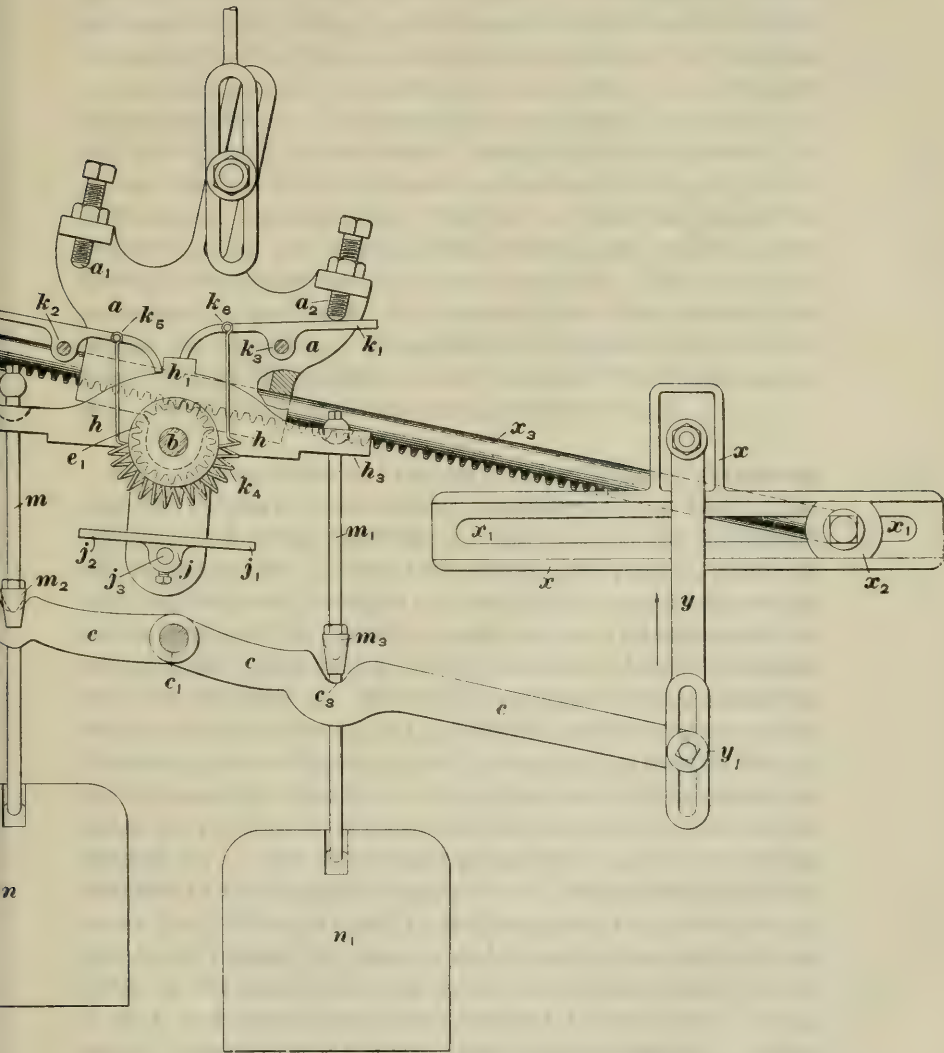
12. Fig. 8 (*a*) and (*b*) shows a style of builder motion that is found on English-built frames. Fig. 8 (*a*) shows this motion as it appears on the frame, while Fig. 8 (*b*) shows the motion with certain of the parts removed in order that its action may be more clearly explained. Attached to the carriage of the fly frame is a bracket x that has a slot x_1 cast in it. A stud x_2 that works in this slot carries a bar x_3, known as the **poker bar,** that passes through a cradle a loose on the shaft b. Attached to the bracket x is an arm y that has connected to it at y_1 a cradle c centered at c_1. It should be carefully noted that as the carriage traverses up and down it will carry with it the bracket x and thus cause the poker bar x_3 to give a rocking motion to the cradle a. At the same time the cradle c will also receive a rocking motion, due to its being connected to the bracket x by the arm y. A vertical shaft d carries the two gears y_2, d_1. The gear y_2 engages with the rack y_3 that carries the belt guide, while the gear d_1 engages with the gear d_2, which is fastened to the shaft b. Fastened to the same shaft are the gears e, e_1, the gear e_1 engaging with teeth on the under side of the poker bar x_3 while the gear e is a ratchet gear and has working in its teeth the stop-pawls e_2, e_3. At the top, or head, of the vertical shaft d is a drum d_3 on which is wound a chain f carrying a weight g; this weight exerts a constant pull on the chain, and were it not for the engagement of the stop-pawls e_2, e_3 with the teeth of the ratchet gear e, would cause the shaft d to revolve until the chain was entirely unwound from the drum. The cradle h, which is loose on the shaft b,



f
d₃
d
y₃
y₂
y₃
g
k
a₂
a
k₁
d₁
e₃
x₃
h₂
e
h₃
b
d₂
e₂
e₄
j₂
j₁
j
j₃
m₁
m₂
c₂
p
m₃
c₃
c
m
p₁
n
p
n₁
q

(a)

FIG. 8


a_1
a_2
k_2
a
k_5
k_6
k_3
a
k_1
h_1
h
e_1
b
h
k_4
h_3
x_3
x
x_1
x_1
x_2
x
y
m
m_1
j_2
j
j_1
j_3
m_2
m_3
c
c
c_1
c_3
c
y_1
n
n_1

(b)

} 25

28127

carries at its lower end a stud j_3 and bracket j, which has two projecting arms j_1, j_2, while at its upper end the cradle has three projections h_1, h_2, h_3. The projection h_1 forms a shoulder against which the two pigeon levers k, k_1 are kept in contact by means of the spring k_4 that passes under the stud b and is connected to the levers at k_5, k_6, respectively, thus exerting a continual pull on the levers k, k_1 in a downward direction toward the shaft b. The levers k, k_1 are centered on studs k_2, k_3 that are secured to the frame. Directly above the points c_2, c_3 of the cradle c are two hooks m_2, m_3 that form part of the rods m, m_1, respectively. The rod m has the weight n attached to its lower end, while at its upper end it passes through the projection h_2 of the cradle h. The rod m_1 is connected to the cradle h in exactly the same manner and carries the weight n_1. Consequently, if the weights are not supported at the points c_2, c_3 by means of the hooks m_2, m_3, they will be suspended from the projections h_2, h_3.

13. The operation of the parts is as follows: Assuming that the carriage is ascending, as indicated by the arrow, carrying with it the poker bar x_3 and raising the right-hand side of the cradle c, as the rail ascends, the point c_2 descends until the rod m with weight n is resting entirely on the end h_2 of the cradle h; the weight n tends to pull h_2 downwards but is prevented from doing so by the lever k being in contact with the shoulder h_1. When the carriage has ascended far enough, the setscrew a_1 that is attached to the cradle a forces down the lever k at its outer end, thus releasing the shoulder h_1 and allowing the cradle h to be pulled over by the weight n, which as previously stated was hanging from h_2, due to the descent of c_2. Not only does the ascent of c_3 allow the rod m attached to the weight n to rest on h_2, but it simultaneously raises the rod m_1 attached to the weight n_1 from the projection h_3, by raising the point c_3 and allowing the weight to be borne by the cradle c at this point, thus avoiding any pull of n_1 on h_3 and also allowing the cradle h to rock freely. The cradle h carries at its lower extremity the bracket j; therefore, if the center of motion is at b, any movement of h_3 will

cause the shoulder h_1 to swing in a similar direction and thus transmit to j a like movement, but in an opposite direction. The downward movement of h_2 causes the shoulder h_1 to swing to the left, and j to swing to the right. In doing so, the arm j_1 forces the pawl e_3 out of contact with the ratchet e and allows the weight g to rotate the vertical shaft d until the pawl e_2 engages with the ratchet e; since e_2 and e_3 are connected by the spring e_4, which has a tendency to draw them together, e_2 will therefore engage with the ratchet e after it has turned half a tooth. The rotation of the shaft d will communicate motion to the rack y_3 by means of the gear y_2, thus moving the belt along the cones for a short distance. At the same time, the gear e_1 will move the poker bar slightly to the left, thus bringing the stud x_2 nearer the cradle a; consequently, on the next traverse the setscrew a_2 will force down the lever k_1 when the carriage has moved a shorter distance than on its previous traverse. Attached to j_3 is an arm p that is centered at p_1. Connected to the lower end of this arm is a rod q that is jointed to the shaft carrying the twin gears. As j_3 is forced one way or the other by the action of the cradle h, it swings the arm p, which, acting on the rod q, causes the opposite twin gear to engage and thus reverses the direction of motion of the carriage.

METHODS OF DRIVING BOBBIN SHAFTS

14. Horse-Head Motion.—Referring again to Fig. 1, it will be remembered that the gear h_5, which is carried by a sleeve on the jack-shaft m, drives, by means of the intermediate gear h_4, the gear h_3 on the end of the back bobbin shaft. An important point to be noted in connection with this drive is that the jack-shaft, which carries the gear h_5, revolves constantly in the same position, while the gear h_3 on the bobbin shaft, which is driven from the gear h_5, is receiving a vertical reciprocating motion, since the shaft carrying this gear forms a part of the bobbin carriage; consequently, some special device must be adopted to keep the three gears h_5, h_4, h_3 constantly in mesh with each other. Fig. 1 shows simply a diagrammatic view of the gearing of

a fly frame, and consequently the device adopted in this connection is not shown; but by referring to Fig. 9 the method adopted to compensate for the rise and fall of the bobbin shaft can be understood. This construction, which is very frequently adopted on fly frames, is commonly known as the **horse-head motion.** The three gears h_5, h_4, h_3 correspond to the same gears in Fig. 1. Swinging loosely on the bearing that carries the jack-shaft m is an arm z that carries at its other end a stud on which the intermediate gear h_4 revolves. Swinging loosely on this same stud is an arm z_1

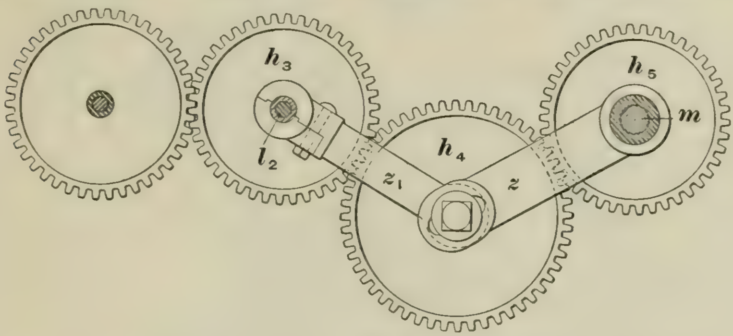


FIG. 9

that is attached at its opposite end to the bearing of the back bobbin shaft, on which shaft is the gear h_3. This connection is similar to that between the arm z and the bearing of the jack-shaft. Since the length of the two arms is always constant and this length is just sufficient to allow the teeth of the three gears to mesh properly, it will readily be seen that as the bobbin shaft rises and falls it will necessarily take the intermediate gear with it and hold it in the correct position for the teeth of the three gears to mesh properly.

15. Vertical and Angle Shaft Motion.—Another method of obtaining the same result is shown in Figs. 10 and 11; it is known as the **vertical and angle shaft motion.** The parts of this motion are as follows: A vertical shaft a extends from the under side of the roll beam almost to the floor, having its lower end pointed and resting in a footstep and its upper end resting in a bearing that is

secured by bolts to the under side of the roll beam. On this shaft is a sleeve *b* that extends into the gear-box at the head of the carriage and is supported by a bracket *c* and flange b_1.

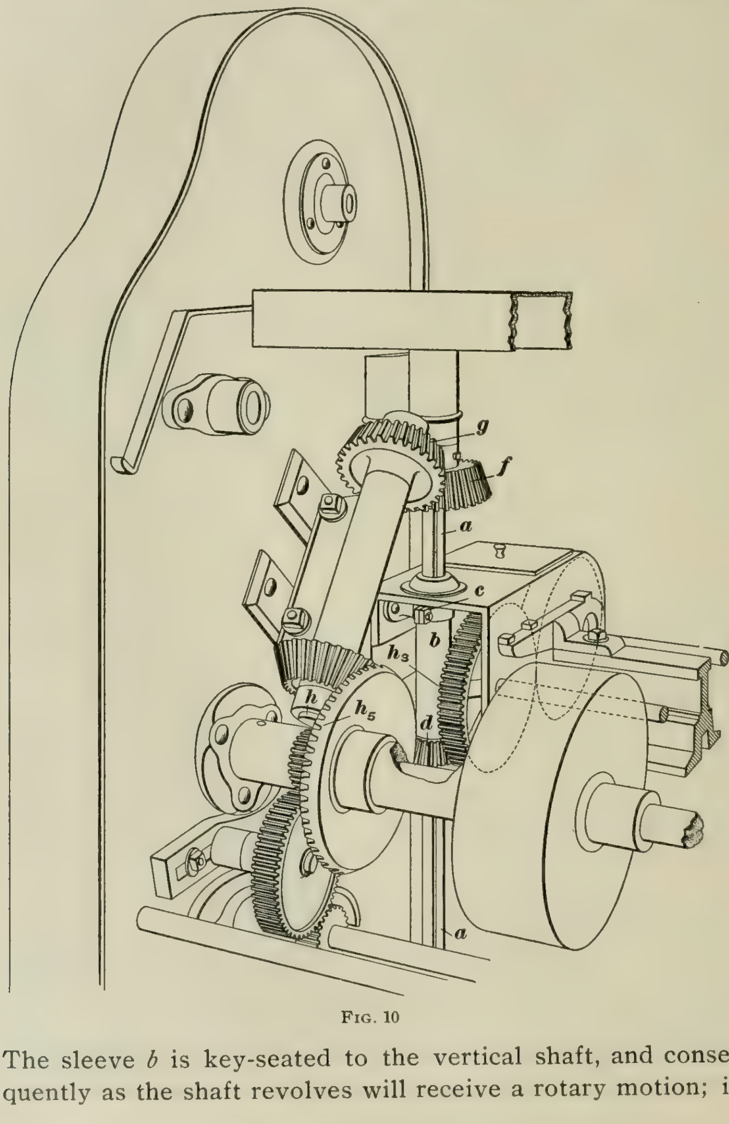


Fig. 10

The sleeve *b* is key-seated to the vertical shaft, and consequently as the shaft revolves will receive a rotary motion; it

is, however, free to be moved up and down on the shaft *a* as may be desired. It will be seen from the construction that as the carriage receives its traversing motion it takes with it the sleeve *b*, fastened to which is a gear *d* that gears into the gear *e* on the back bobbin shaft. Setscrewed to the upper end of the vertical shaft *a* is a bevel gear *f* receiving motion from the bevel gear *g* at the upper end of the angle

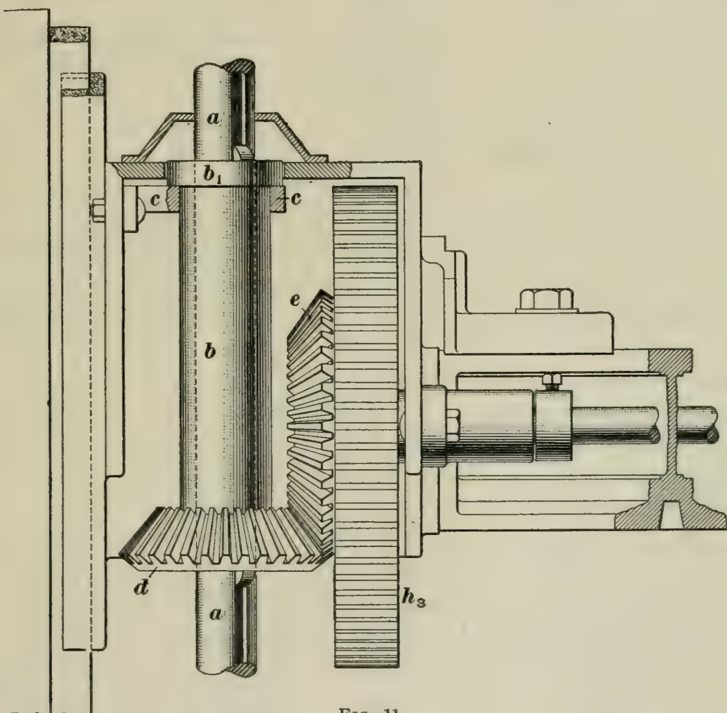


FIG. 11

shaft *h*. At the lower end of this angle shaft is another bevel gear driven by the beveled bobbin gear h_5 on a sleeve on the jack-shaft. By this means the vertical shaft *a*, which receives motion from the jack-shaft through the train of gears just described, is constantly imparting motion to the gear *d* on the sleeve *b*, although this sleeve traverses up and down the shaft together with the bobbin rail.

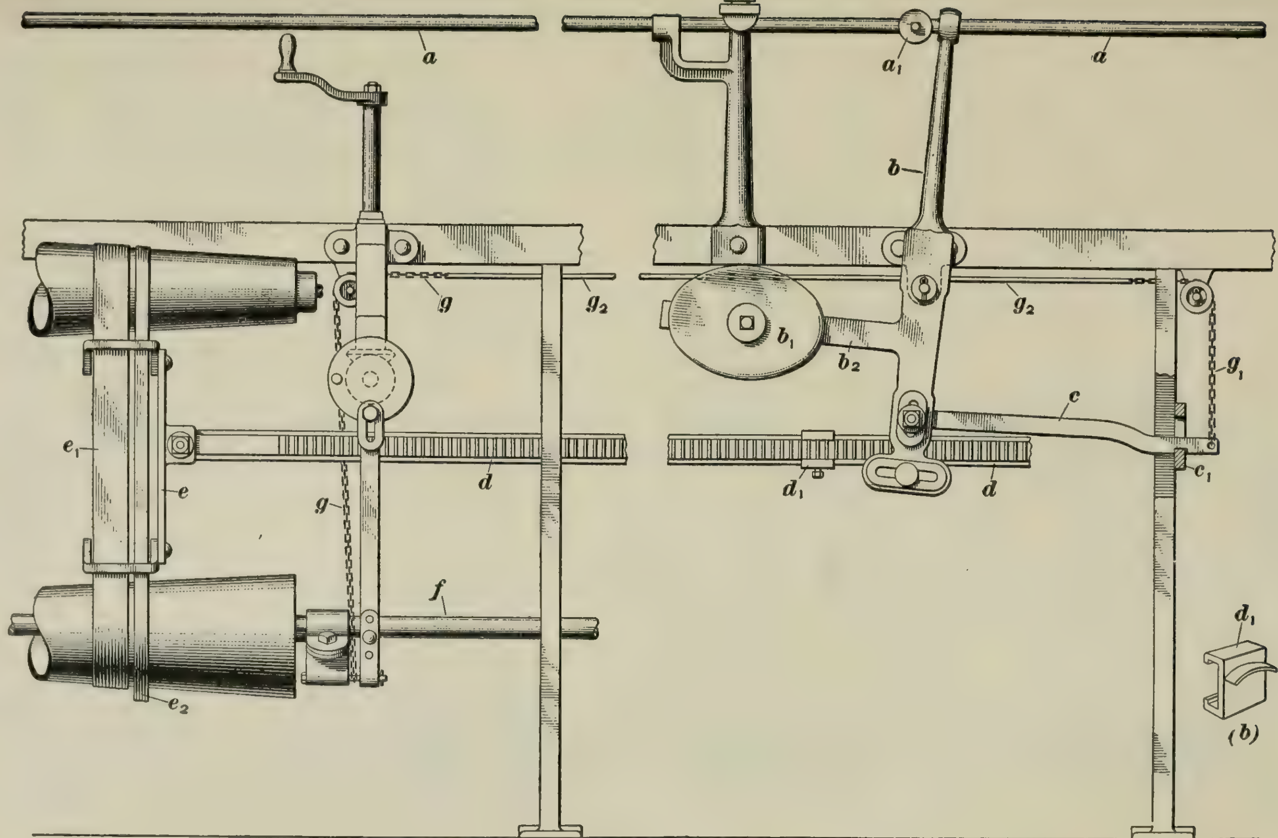
STOP-MOTIONS

16. The **full-bobbin stop-motion** of a fly frame is very simple and is found on most fly frames. The shipper rod *a*, Fig. 12 (*a*), extends the entire length of the frame and passes through the eye of the knock-off lever *b*, which is pivoted to a bracket attached to the roll beam. The knock-off lever carries an arm b_2 that supports a heavy weight b_1, while near the lower part of the lever is pivoted a knock-off latch *c* that passes through an opening in one of the sampsons; this sampson carries a bracket c_1 that is engaged by a slot in the latch, thus holding the latch in position. The rack *d*, which carries the belt guide *e*, also has a knock-off dog d_1 attached to it by means of a setscrew. A perspective view of this knock-off dog is shown in Fig. 12 (*b*).

During the building of the bobbin the cone belt is moved along the cones by the movement of the rack, which moves slightly toward the foot end of the frame at the completion of each traverse. When the bobbins have become full the belt is at the small end of the top cone and the rack has moved some distance to the right; consequently, on account of the position of the knock-off dog on the rack, this dog passes under the knock-off latch and raises it, thus allowing the weight b_1 to throw the upper end of the knock-off lever *b* to the left so that it strikes the ball a_1 attached to the shipper rod. As the lever continues its movement it moves the shipper rod toward the head end of the frame and ships the driving belt from the tight to the loose pulley.

The frame can be set to knock off whenever the bobbins have attained their correct size. This is accomplished by moving the knock-off dog on the rack so that it will pass under the latch and release it when the bobbins are of the desired size.

17. A great deal of trouble and bad work results on fly frames from the cone belt breaking. In Fig. 12 (*a*) a patent knock-off motion is shown, which stops the frame and at the same time prevents the ends from breaking down at the front



(a)
FIG. 12

when the cone belt breaks. The lower cone is supported by a frame that swings on the back shaft f and is capable of being raised or lowered; the shaft f is the one that imparts motion to the racks that actuate the carriage. The chains g, g_1 and the rod g_2 form a connection between one of the bearings of the bottom cone and the knock-off latch. The shipper e carries two belts e_1, e_2. The wide belt e_1 is the main cone belt and is used to drive the bottom cone. The belt e_2 is a little longer than e_1, so that it will not come in contact with the bottom cone when the frame is running properly. When the belt e_1 breaks, the lower cone falls until it comes in contact with the auxiliary belt e_2, which is long enough to allow the lower cone to drop sufficiently to release the latch c by means of the chain-and-rod connection. When the latch c is released the knock-off lever forces the shipper rod toward the head of the frame, so that the belt is moved from the tight to the loose pulley. The auxiliary belt keeps the lower cone in motion until the frame has stopped, and thereby prevents the ends from breaking down at the front.

CREEL

18. Although the slubber has been taken to illustrate the construction of fly frames, it will be found that the descriptions given will apply equally well to any of the machines grouped under the head of fly frames. Outside of the difference in the size of the parts of the different frames, the only noticeable difference between the slubber and the other frames is in the manner of feeding the cotton at the back. As the slubber takes the sliver from the cans that are filled at the drawing frames, these cans are placed behind the slubber in a similar manner to that adopted at the drawing frames and other machines to which the cotton is fed from cans. On the other hand, the roving comes to the later fly frames on bobbins, and it is consequently necessary to provide some means by which these bobbins may be supported and yet allowed to revolve freely as the roving is being unwound from them. Any arrangement in cotton-mill machinery that

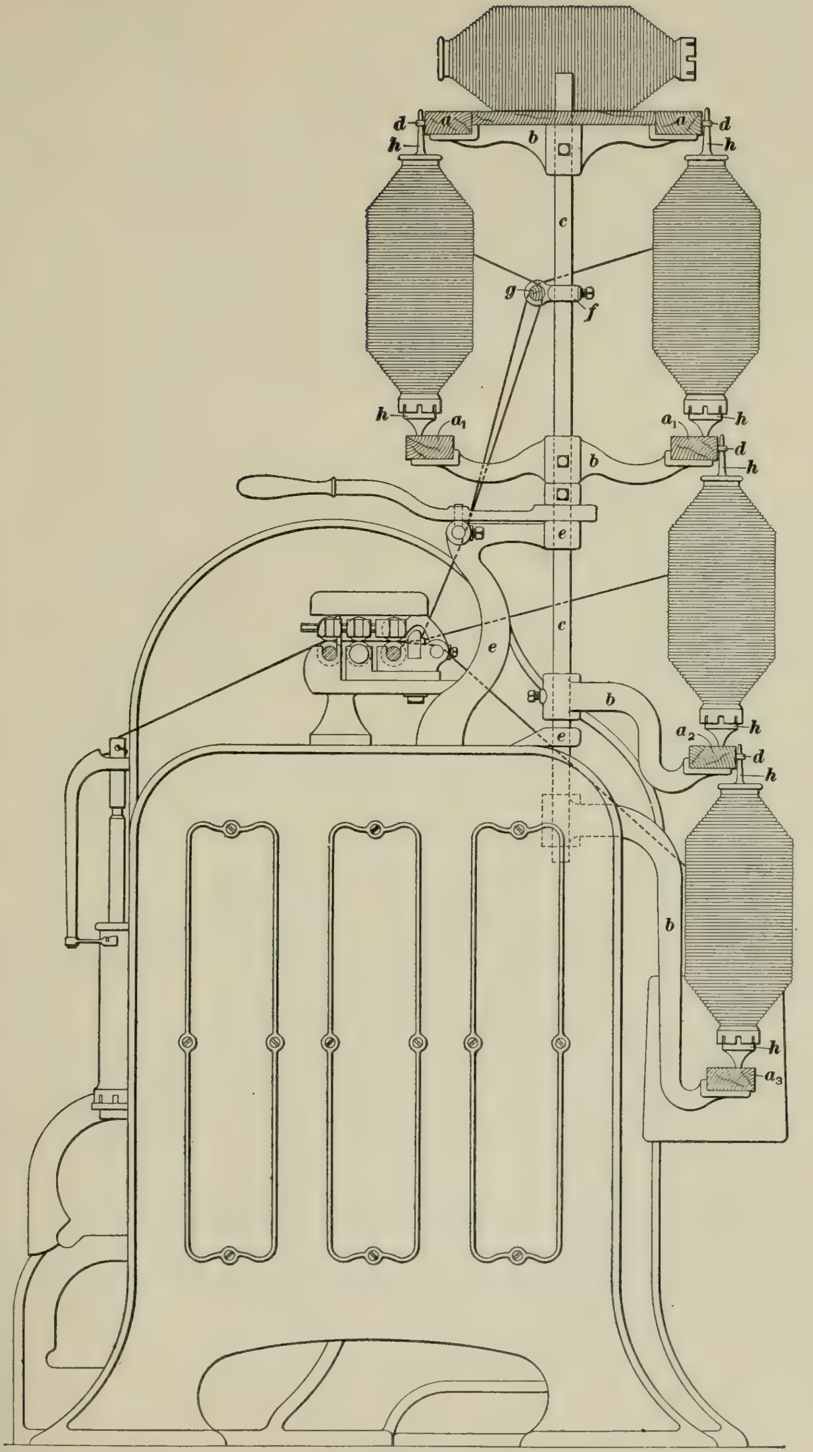


FIG. 13

serves to support bobbins or spools is generally termed a **creel.** Fig. 13 shows the creel, together with other parts, of a first intermediate fly frame. The creel consists of a framework that extends the entire length of the machine at the back and is built up of the required number of wooden rails a, a_1, a_2, a_3, which are supported by brackets b that are setscrewed to the rods c and are capable of being adjusted up or down in order to have the desired space between any two. On their upper sides the rails, with the exception of the top ones, carry glass cups, or steps, while directly over each cup is a metal eye d fastened to the rail above. The rods c to which the brackets b are setscrewed are supported by brackets e bolted to the roll beam; these rods, in addition to carrying the brackets b, also support small brackets f through which the rod g passes. This rod serves as a guide for the roving as it is unwound from the upper bobbins.

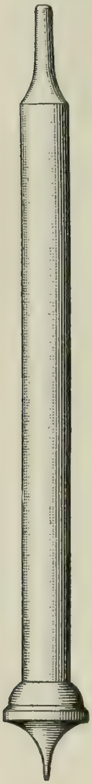


Fig. 14

In placing the full bobbins in the creel wooden skewers are used. These skewers are shown at h, Fig. 13, a skewer alone being shown in Fig. 14. They are slightly longer than the bobbins and, as shown in Fig. 13, pass completely through them, the lower end of each skewer resting in the cup on the top of the rail, while its upper end passes through the eye inserted in the edge of the rail above. A shoulder at the lower end of the skewer prevents the bobbin from dropping below this position, and as it is practically only the friction of the bottom point of the skewer in the glass cup that must be overcome, the bobbins revolve with a minimum of resistance.

The top of the creel is of sufficient width to support full bobbins, and it is the custom to place them side by side and from two to three tiers high along the entire top of the creel. This provides for a sufficient number of full bobbins to take the place of those already in the creel when they become empty.

FLY FRAMES

(PART 3)

MANAGEMENT OF FLY FRAMES

CALCULATIONS

1. In connection with fly frames there are numerous calculations that it is necessary to understand. Many of these refer to speeds and drafts, on which general information and rules have been given in dealing with mechanical and draft calculations; examples of all necessary calculations are given in this Section, but the rules dealing with speeds and drafts are omitted. The examples apply to the gearing shown in Fig. 1, and to a bobbin-lead type of frame.

EXAMPLE 1.—Find the speed of the jack-shaft when the main shaft makes 300 revolutions per minute and carries a 20-inch pulley driving a 16-inch pulley on the jack-shaft.

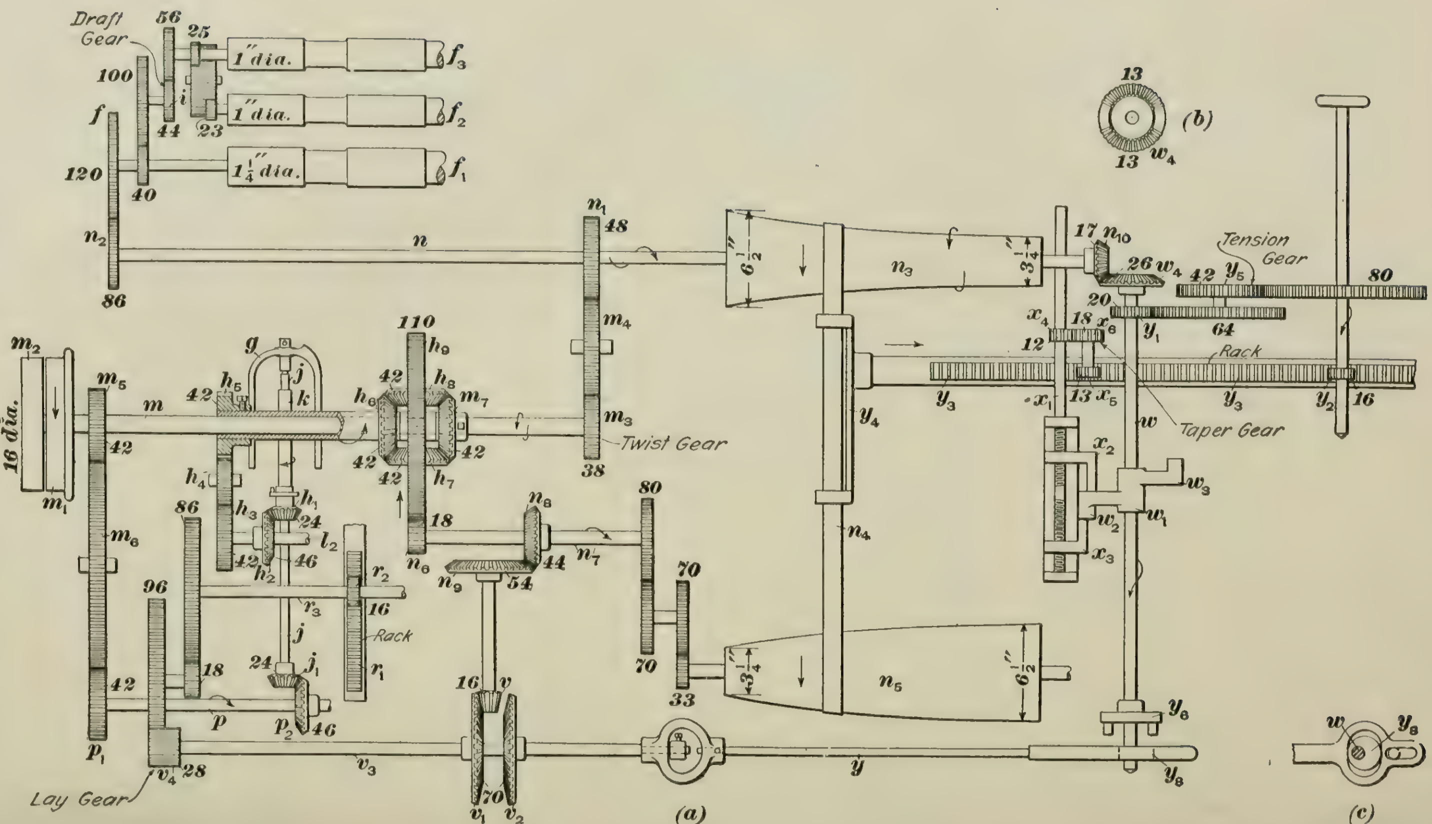
SOLUTION.— $\frac{300 \times 20}{16} = 375$ rev. per min. of jack-shaft. Ans

EXAMPLE 2.—Find the revolutions per minute of the top-cone shaft when the jack-shaft makes 375 revolutions per minute and carries a 38-tooth twist gear driving a 48-tooth gear on the top-cone shaft.

SOLUTION.— $\frac{375 \times 38}{48} = 296.875$ rev. per min. of top-cone shaft. Ans.

EXAMPLE 3.—Find the revolutions per minute of the front roll when the top-cone shaft makes 296.875 revolutions per minute and carries an 86-tooth gear driving a 120-tooth gear on the front-roll shaft.

SOLUTION.— $\frac{296.875 \times 86}{120} = 212.76$ rev. per min. Ans.



Draft Gear
Tension Gear
Rack
Taper Gear
Twist Gear
Rack
Lay Gear
1" dia.
1" dia.
1¼" dia.
16" dia.
(a)
(b)
(c)

FIG. 1

EXAMPLE 4.—Find the length of roving delivered per minute by the front roll when it is 1.25 inches in diameter and makes 212.76 revolutions per minute.

SOLUTION.— $\frac{212.76 \times 1.25 \times 3.1416}{36} = 23.208$ yd. per min. Ans.

EXAMPLE 5.—Find the number of revolutions of the spindles to 1 revolution of the jack-shaft when the jack-shaft carries a 42-tooth gear driving a 42-tooth gear on the spindle-gear shaft, which carries a 46-tooth gear driving a 24-tooth gear on the lower end of the spindle.

SOLUTION.— $\frac{1 \times 42 \times 46}{42 \times 24} = 1.916$ rev. of spindles to 1 rev. of jack-shaft. Ans.

EXAMPLE 6.—Find the revolutions per minute of the spindles when the jack-shaft makes 375 revolutions per minute and the spindles make 1.916 turns to one of the jack-shaft.

SOLUTION.— $375 \times 1.916 = 718.5$ rev. per min. of spindles. Ans.

2. To find the twist, or turns, per inch:

Rule I.—*Divide the revolutions per minute of the spindles by the length of roving, in inches, delivered by the front roll in the same time.*

EXAMPLE 1.—Find the turns per inch being placed in the roving if the spindles make 718.5 revolutions per minute and the front roll delivers 23.208 yards per minute.

SOLUTION.— $23.208 \times 36 = 835.488$ in. per min.; $718.5 \div 835.488 = .859$ turn per in. Ans.

Rule II.—*Taking into consideration all the gears, with the exception of the carrier gears, from the front roll to the spindles, assume that the front-roll gear is a driver. Multiply together all driving gears and divide by the product of all the driven gears. Divide the quotient thus obtained by the circumference of the front roll.*

EXAMPLE 2.—Find the turns per inch being inserted in the roving with the following arrangement of gears: the front roll is 1.25 inches in diameter; front-roll gear has 120 teeth; gear on end of top-cone shaft, 86 teeth; top-cone gear, 48 teeth; twist gear, 38 teeth; jack-shaft gear, 42 teeth; spindle-shaft gear, 42 teeth, gear on spindle-shaft driving spindle, 46 teeth; gear on spindle, 24 teeth.

SOLUTION.— $\frac{120 \times 48 \times 42 \times 46}{86 \times 38 \times 42 \times 24} = 3.378$; $\frac{3.378}{1.25 \times 3.1416} = .86$ turn per in. Ans.

3. To find the constant for twist:

Rule.—*Apply rule II, in Art.* **2**, *for finding the twist, considering the twist gear as a 1-tooth gear.*

EXAMPLE—Find the constant for twist, using the train of gearing given in example 2 in Art. **2** for finding the twist.

SOLUTION.— $\frac{120 \times 48 \times 42 \times 46}{86 \times 1 \times 42 \times 24} = 128.372$; $\frac{128.372}{1.25 \times 3.1416} = 32.689$, constant dividend for twist. Ans.

The constant dividend divided by the twist gear equals the twist per inch; thus, $32.689 \div 38 = .86$, twist per in. Ans.

4. To find the speed of the bobbins:

Rule.—*Find the amount of roving wound on the bobbins per minute and divide by the circumference of the bobbin. Add the result thus obtained to the speed of the spindles per minute, and the answer is the speed of the bobbins per minute.*

EXAMPLE 1.—Find the speed of the bobbins at the beginning of a set when the diameter of the bobbin is 1.75 inches; the speed of the spindles, 718.5 revolutions per minute; and the front roll delivers 835.488 inches per minute.

SOLUTION.— $\frac{835.488}{1.75 \times 3.1416} = 151.967$ rev. per min. of bobbins over speed of spindles. Speed of the spindles, 718.5 rev. per min.; speed of bobbins over that of the spindles, 151.967. $718.5 + 151.967 = 870.467$, speed of bobbins at beginning of set. Ans.

EXAMPLE 2.—Find the speed of the bobbins at the finish of a set when the diameter of the full bobbin is 6.125 inches; the speed of the spindles, 718.5 revolutions per minute; and the front roll delivers 835.488 inches per minute.

SOLUTION.— $\frac{835.488}{6.125 \times 3.1416} = 43.419$ rev. per min. of the bobbins over the spindles. The number of revolutions per minute of the spindles is 718.5; the speed of the bobbins over that of the spindles is 43.419. $718.5 + 43.419 = 761.919$ rev. per min. of bobbins at the finish of a set. Ans.

The reduction of the speed per minute of the bobbins from an empty bobbin to a full bobbin in the above case is $870.467 - 761.919 = 108.548$ revolutions.

5. Drafts.—The draft of a fly frame is calculated in the usual manner.

EXAMPLE 1.—Find the total draft of the rolls shown in Fig. 1, using a 44 draft gear.

SOLUTION.— $\frac{1.25 \times 100 \times 56}{40 \times 44 \times 1} = 3.977$, total draft. Ans.

The constant for draft is found in the same manner as the total draft, except that the draft gear is considered as a 1-tooth gear.

EXAMPLE 2.—Find the draft constant for the rolls shown in Fig. 1.

SOLUTION.— $\frac{1.25 \times 100 \times 56}{40 \times 1 \times 1} = 175$, constant. Ans.

EXAMPLE 3.—Find the draft between the second and third rolls.

SOLUTION.— $\frac{1 \times 25}{23 \times 1} = 1.086$, draft between second and third rolls. Ans.

EXAMPLE 4.—Find the draft between the front and second rolls if the draft gear contains 44 teeth.

SOLUTION.— $\frac{1.25 \times 100 \times 56 \times 23}{40 \times 44 \times 25 \times 1} = 3.659$, draft between front and second rolls. Ans.

6. Change Gears.—In addition to the calculations given there are several in connection with fly frames that apply particularly to the gears that should be used to produce satisfactory work. It will readily be understood that if a frame is running on a certain hank roving and it is desired to change to a different hank, certain gears must be changed in order that correct results may be obtained. In changing from one hank to another some or all of the following gears must be altered (the reference letters apply to Fig. 1): (1) the twist gear m_3, which alters the speed of the rolls and regulates the turns per inch placed in the roving; (2) the tension gear y_5, which regulates the movement of the belt along the cones; (3) the draft gear i, which alters the hank of the roving delivered; (4) the taper gear x_6, which alters the taper of the bobbin; (5) the lay, or traverse, gear v_4, which alters the speed of the traverse of the carriage.

These are the American names for these gears; the English builder motion is different from the American and the English name for tension gear is rack wheel, for taper gear is taper wheel, and for lay gear is lifter wheel.

The most important change to make is in the draft change gear, which regulates the size of the roving. It is generally customary at the same time to change the twist gear, because this should vary with every change in the hank of the roving. The tension gear is also frequently changed. It is not customary, however, to change the lay gear unless the change in the hank of the roving is extensive. If the slubber roving is changed .3 hank, the first intermediate roving .5 hank, the second intermediate roving .75 hank, or the finished roving a whole hank, the lay gear will ordinarily be changed.

It is seldom that the taper gear is changed in the mill, since the gear that is placed on the frame by the builders usually serves for the range of different hank roving that the frame is intended to make.

It is important to bear in mind whether an increase or decrease in the size of a gear must be made to produce certain results. On the usual construction of American-built frames, in making a change to produce finer work the draft gear, the twist gear, the lay gear, and the tension gear would be changed to smaller gears; on the other hand, if the frame must be changed to make coarser work, they would be changed for larger gears, if required to be changed at all.

The same statement is correct with regard to English-built frames, or American-built frames having an English type of builder, with the exception of the tension gear, which in case of changing the frame finer, would be changed to a gear having a larger number of teeth, or in case of changing the frame coarser, to a gear having a smaller number of teeth.

The following rules apply to the method of figuring the different change gears when the gears that are on the frame and the hank roving being produced are known. From the calculations previously given it is possible to obtain the draft and twist gears without this data, but for the tension and lay gears this data is always necessary, since the correct gear for starting up a frame was obtained by the builders largely by experiment and not by calculation. Even when the gear to use for a certain hank roving is known, the calculated gear for another hank does not always give satisfactory

results, since the changing of these gears is largely a matter of experience and observation, owing to a number of different points affecting the results produced by them, such as the amount of twist put in the roving, the condition of the cone belt, the number of times that the roving is wound around the presser on the flyer, and so forth.

7. To find the draft gear to be used for a certain hank roving when the draft gear that is on and the hank roving that it produces are known:

Rule.—*Multiply the draft gear being used by the hank roving that it produces, and divide the result by the hank roving that is to be made.*

EXAMPLE.—If 4-hank roving is being produced with a 32-tooth draft gear, what draft gear will a 6-hank roving require?

SOLUTION.— $32 \times 4 = 128$; $128 \div 6 = 21.333$, or practically a 21-tooth draft gear. Ans.

8. To find the twist gear to be used for a certain hank roving when the twist gear that is on and the hank roving that is produced are known:

Rule.—*Multiply the square root of the hank being made by the twist gear, and divide by the square root of the hank required.*

In examples in which the diameter of the roving affects the size of the gear to be used it is necessary to consider the square roots of the hanks, since the diameters of rovings vary inversely as the square roots of their hanks.

EXAMPLE.—If .36-hank roving is being made with a 54-tooth gear, what twist gear is required for a .64-hank?

SOLUTION.— $\sqrt{.36} = .6$; $\sqrt{.64} = .8$; $.6 \times 54 = 32.4$; $32.4 \div .8 = 40.5$. Either a 41-tooth or a 40-tooth gear may be used. Ans.

9. To find the tension gear to be used for a certain hank roving when the tension gear that is on and the hank roving that is produced are known, the frame having the American type of builder:

Rule.—*Multiply the square root of the hank being made by the tension gear, and divide by the square root of the hank required.*

EXAMPLE.—If .36-hank roving is being made with a 50-tooth tension gear, what tension gear is required for a .64-hank?

SOLUTION.— $\sqrt{.36} = .6$; $\sqrt{.64} = .8$; $.6 \times 50 = 30$; $30 \div .8 = 37.5$. Either a 37-tooth or a 38-tooth gear may be used. Ans.

To find the tension gear to be used for a certain hank roving when the tension gear that is on and the hank roving that is produced are known, the frame having the English type of builder:

Rule.—*Multiply the square root of the hank required by the tension gear, and divide by the square root of the hank being made.*

EXAMPLE.—If .36-hank roving is being made with a 20-tooth tension gear, what tension gear is required for a .64-hank?

SOLUTION.— $\sqrt{.36} = .6$; $\sqrt{.64} = .8$; $.8 \times 20 = 16$; $16 \div .6 = 26.666$. A 27-tooth gear would be used. Ans.

10. To find the lay gear to be used for a certain hank roving when the lay gear that is on and the hank roving that is produced are known:

Rule.—*Multiply the square root of the hank being made by the lay gear, and divide by the square root of the hank required.*

EXAMPLE.—If .36-hank roving is being made with a 33-tooth gear, what lay gear is required for a .64-hank?

SOLUTION.— $\sqrt{.36} = .6$; $\sqrt{.64} = .8$; $.6 \times 33 = 19.8$; $19.8 \div .8 = 24.75$. A 25-tooth gear should be used. Ans.

11. Production.—To find the production of a fly frame, in pounds:

Rule.—*Multiply the hanks per spindle, as indicated by the hank clock, by the number of spindles, and divide by the hank roving.*

EXAMPLE.—A clock on a 72-spindle frame registers 75 hanks of .5-hank roving turned off in a week. What is the production in pounds?

SOLUTION.— $\frac{75 \times 72}{.5} = 10{,}800$ lb. production. Ans.

12. Average Hank.—To find the average hank, or average number, of the roving when several hanks are being run:

Rule.—*Multiply the pounds of each hank produced by the number of the hank, and divide the total of the products thus obtained by the total of the pounds produced.*

EXAMPLE.—If 1,800 pounds of .50-hank, 700 pounds of 1.50-hank, 850 pounds of 2-hank, 800 pounds of 2.25-hank, 750 pounds of 4-hank, and 700 pounds of 10-hank are produced in a week, what is the average hank of the roving?

SOLUTION.—

$$
\begin{array}{rrr}
1800 \times & .50 = & 900 \\
700 \times & 1.50 = & 1050 \\
850 \times & 2.00 = & 1700 \\
800 \times & 2.25 = & 1800 \\
750 \times & 4.00 = & 3000 \\
700 \times & 10.00 = & 7000 \\
\hline
\text{Total, } 5600 \text{ pounds} & & 15450 \text{ hanks}
\end{array}
$$

15,450 ÷ 5,600 = 2.758, average hank. Ans.

STARTING FLY FRAMES

13. Draft.—In starting fly frames, one of the first points to be considered is the arrangement of the **drafts** in the different frames. As a general rule, the drafts in the intermediate frames should be less than the draft in the roving frame and slightly greater than that in the slubber. It is not always possible, however, to arrange a series of fly frames so as to give the best theoretical drafts, since one process must keep up with another, and it is customary for those in charge to change the drafts until the production of one nicely balances that of the other; that is, if the slubbers are making too many bobbins for the intermediates, the draft of the slubber is increased so as to make a finer roving, and the draft in the intermediates decreased because finer roving is fed at the back, thus making the same hank at the front as in the former case but using a greater length of back roving. Speaking generally, it may be said that on coarse work or in mills making below 36s yarn it is best to arrange

the draft of the slubber about 4, intermediate about 5, and the roving frame about 6. The following is an organization used when starting fly frames for 28s warp and 36s filling. A 55-grain sliver at the drawing frame (equal to about .151 hank) and 4.5 draft at the slubber gives .68-hank slubbing; 5.5 draft at the intermediate, doubling 2, gives a 1.87-hank roving; and a 6.5 draft at the roving frame, doubling 2, gives a 6.07-hank roving. Other organizations are as follows: For a 4.5-hank roving at the roving frame, a .5-hank roving is usually produced at the slubber and a 1.5-hank roving at the intermediate, with a draft of 6 at both the intermediate and roving frames. For a 10-hank roving, the following are good drafts: slubber, 4; first intermediate, 4.5; second intermediate, 5; roving frame, 5. For a 20-hank roving, the following are good drafts: slubber, 4.5; first intermediate, 5; second intermediate, 6; roving frame, 6.5.

In connection with the drafts in the different fly frames, an important point always to be taken into consideration is the production that different drafts will give. In making any change of hank, it should be clearly understood that changing to finer roving means reduced production, not only on account of the reduced weight per yard of the roving, but also because the speed of the front roll must be reduced in order to obtain the extra twist that is required for the finer hank. Sometimes the experiment is tried of putting a small pulley on the frame so as to bring the speed of the front roll up to the original speed and increase the speed of the spindles, but this is not often advisable, as too great speed makes the work run badly and consequently reduces the production.

14. Twist.—Having obtained the correct drafts for the different frames, the next important point to be considered is the **twist** to be placed in the roving. In this connection, it should be distinctly understood that the amount of twist in the roving depends on the relation that the speed of the spindles bears to that of the front rolls. Twist may be increased in roving either by decreasing the speed of the

delivery rolls or increasing the speed of the spindles. The spindles of each kind of fly frames in a mill are usually run at a certain number of revolutions per minute, which has been found most desirable in practice, and any great increase over this number causes the work to run badly. On this account, whenever it is desired to insert more twist in the roving, it is the usual practice to decrease the speed of the front rolls. This, however, decreases the production of the frame, and consequently no more twist should be placed in the roving than is absolutely necessary to allow it to draw off well at the next process without stretching and breaking. Not only does any twist above this amount decrease the production, but it also makes the roving draw badly and is liable to damage the leather top rolls on the next frame. The amount of twist placed in roving varies according to the hank being produced and the stock being used. It has been found practical to insert a number of turns per inch that is equal to the product of the square root of the hank and certain numbers used as constants. The following table gives the constants that are commonly used for American, Egyptian, and sea-island cotton on the slubber, first intermediate, second intermediate, and roving frames.

TABLE I

Cotton	Slubber	First Intermediate	Second Intermediate	Roving Frame
American . . .	1.0	1.1	1.20	1.3
Egyptian . . .	.9	1.0	1.10	1.2
Sea-island . . .	.7	.8	.90 to .95	1.0

It is generally assumed that a good test for determining whether sufficient twist is being placed in the roving is to feel each bobbin to see that it is not too hard or too soft, although it should be borne in mind that a hard bobbin may be formed from roving having less than the standard twist if a presser with a heavy vertical rod is used.

15. Speed.—It has been stated that the spindles on fly frames are run at a uniform speed, but in this connection it may be well to consider what speeds are best for the different frames. The speed of the spindles on a slubbing frame may slightly exceed 600 revolutions per minute; on a first intermediate frame 900 revolutions per minute is a good speed; on a second intermediate, 1,200; and on a roving frame, 1,500 revolutions per minute. These speeds, of course, are often exceeded in many mills. In some cases it would be more accurate to give the speeds at 800, 1,000, 1,300, and 1,600 revolutions, respectively, for the four machines. Experience, however, has demonstrated that in fly frames high speeds, particularly when the cotton is not up to the standard, are objectionable. No definite number of revolutions per minute can be given for the spindles of fly frames, since this is dependent largely on circumstances. It may sometimes be advisable to run more slowly than the speeds given above, since old frames, coarse work, or inferior stock will necessitate slower speeds than new frames, fine work, or good stock.

When once the correct ratio of speed between the front roll and the spindle has been found, the only way of increasing production is to increase the speed of the whole frame. Theoretically, every time the frame is speeded up the production ought to increase, although in practice this is not found to be so, since there is a limit to the speed of every machine beyond which it is not advisable to go, because an excessive speed causes unnecessary wear and tear to take place and results in a large number of ends breaking; this is an especially important matter in connection with fly frames, since the whole frame must be stopped to piece one broken end.

16. Build of Bobbin.—After deciding on the draft to be used in the frame and the number of turns per inch to be inserted in the roving, a few bobbins may be placed in the creel, considering that one of the frames other than the slubber is being dealt with. The ends of roving from two bobbins are passed through the drawing rolls and pieced at

the front. One layer should then be run on the bobbin and the length of traverse adjusted so as to obtain a layer of as great a length as possible without the finger of the presser striking the ends of the bobbin. The proper lay gear may also be chosen at this point. In order to obtain a well-built bobbin, the coils in the first layer should be laid so that the wood of the bobbin can barely be seen between them. Should the first experimental bobbin show the coils either closer or farther apart than this, the lay gear should be changed accordingly. The correct lay gear is largely a matter of experiment and experience, and different millmen have different ideas as to the correct gear that should be used. For accurate work, it is advisable to count the number of coils per inch that are made on the bare bobbin, when satisfactory results are obtained, for various hanks of roving. From these records a table of constants can be prepared, which can be used for reference. It is found in practice that the most suitable number of coils per inch varies from seven to ten times the square root of the hank roving being produced, the smaller multiplier being used for slubbers and intermediates and the larger one for roving frames. For example, in case of making 4-hank roving, the square root of which is 2, if 10 is used as a multiplier, 20 coils per inch will be placed on the bare bobbin. Other factors enter into the question as to the spacing of these coils; for instance, the amount of twist placed in the roving, the grade of cotton being used, and whether the stock has been carded or both carded and combed, all have an effect on the number of coils per inch that can be advantageously placed on the bobbin.

17. Tension.—By referring to Fig. 1, it will be noted that on the end of the bottom cone is a gear driving, by means of suitable gearing, a gear on the compound. When starting up a new frame, it should be carefully noted whether the roving is running at the correct tension; and if it is not, this cone gear should be changed until the right tension is obtained. A gear of fewer teeth will drive the bobbins more slowly, causing less tension on the ends, while a gear of

more teeth has the opposite effect. In some cases, instead of changing the cone gear, the proper tension is obtained by starting the belt at a different position on the cones. This, however, is not good practice and should not be allowed. The belt should always be started at the end of the cones when winding the first layer on the bobbin, and the cone gear be of such size as to give the proper tension with the belt in this position. This cone gear should be changed only when the frame is being started for the first time, and after the correct gear has once been obtained it should not be changed unless the diameter of the empty bobbin is changed. It is very important to have the tension properly adjusted, since a difference of from 10 to 15 per cent. in the weight of the roving on the full bobbin may be made by not having the correct cone gear, besides causing the frame to produce unsatisfactory work.

18. Creeling.—After the different gears have been put on and the length of the traverse has been adjusted, the frame may be considered ready for starting up. The next process is **creeling**; that is, placing the bobbins of roving in the creel at the back of the frame and passing the ends of roving from them to the rolls. In this connection, it is important to note that all the bobbins placed in the creel at one time should not be of the same size, since in this case they would all become empty at about the same time and thus cause the tender to replace empty bobbins with full ones in so short a period of time that it would either necessitate stopping the frame or result in certain bobbins running empty before full bobbins had been put in their place. In creeling, it is good practice to put up two rows of full bobbins and two rows of half-filled bobbins, having the roving from one full and one half-filled bobbin run together, thus causing only a part of the bobbins to become empty at one time and obviating the difficulty that arises when the bobbins all run empty at the same time.

Other points to be noted in creeling are that bobbins should not be inserted that will touch the next bobbin, since this prevents the easy unwinding of the roving. Sometimes

bobbins unwind too freely, resulting in what is known as overrunning. To prevent this a little piece of cotton is sometimes inserted under the foot of the skewer to cause friction and thus retard the rotation of the bobbin. On the other hand, bobbins containing roving that is too soft are sometimes placed in the creel at the back of the frame, in which case the roving breaks instead of unwinding. To remedy this difficulty the skewers are taken out and sharpened at the bottom so as to lessen the friction.

19. Having pieced up all the ends, the frame may be started. During the time that the first set is being filled the different parts of the frame should be carefully watched, especial notice being taken of the tension on the roving and the build of the bobbin. Frames vary somewhat in their capacity for making a well-built bobbin, but as a rule the taper of the ends of a full bobbin should not be too great, since, if the slant is too great, it prevents the winding of a sufficient length of roving on the bobbin and necessitates too frequent creeling at the succeeding processes. On the other hand, the ends of the bobbin should not be built in such a manner that they will be almost at right angles with the bobbin, since in this case the ends are liable to run under during winding and thus cause unnecessary breakage of ends.

CARE OF FLY FRAMES

20. **Single and Double.**—After the frames have been well started, several points in the management need careful attention. Perhaps the most important points are what are technically known as **single** and **double.** These may be caused in several different ways. For example, in fly frames that follow the slubber, where two ends are run into one at the back, it frequently happens that only one end passes through the guide eye of the traverse rod, while the end that should be joined to this one runs through a guide eye with two other ends; thus, instead of having two ends in each case, in one case there will be a single end and in the other, three ends. Again, it frequently happens that

certain of the ends as they leave the delivery rolls at the front of the frame break, and the strong current of air set up by the rapidly revolving flyers causes these ends to become twisted in with an end running on to another bobbin. If the tender does not notice this at the time it occurs, there is a liability of several layers of roving being wound on the bobbin that contain double the thickness that they should. In still other cases, when an end breaks as it comes from the delivery roll, it may happen that only part of the roving is twisted in with the adjoining end, while the other part winds around one of the rolls, forming what is called a roll lap. All these cases occur frequently on fly frames and are the cause of bad work. As will be seen, when double, which is greater than the required size, for the reasons just given, is wound on the bobbin, the diameter of the bobbin will be increased out of its regular proportion, thus causing the roving to be strained; while on the other hand, in case of single, which is less than the required size, the diameter of the bobbin is not increased in its correct proportion, causing the roving to run slack. When single or double occurs on fly frames, it is necessary for the tender to stop the frame and unwind the defective roving from the bobbin. In some cases so much imperfect roving has been wound on the bobbin that the correct diameter of the bobbin cannot be obtained in that set. It then becomes necessary to break out the ends fed to it, thus causing a spindle to be unproductive throughout the filling of the rest of the set, and consequently the production of the frame to be lessened. This is a practice that should not be allowed, and tenders should be required to watch their frames carefully for single or double rovings and correct the defect immediately. If the single or double roving is not removed from the bobbin, it passes forwards to the next process and there working in with a perfect end produces roving or yarn of the wrong number.

21. Piecing.—The piecing of roving, when broken at the front, is accomplished as follows: The frame is stopped and the tender unrolls an arm's length of roving from the

bobbin, twisting it slightly by rolling it between the palms of the hands in order to give it greater strength. The roving is then inserted in the hollow leg of the presser by holding the loose end in one hand and with the other hand sliding the roving along the slot in the side of the leg. That part of the roving that passes from the bottom of the hollow leg to the bobbin is now wound around the presser as many times as necessary and inserted in the eye of the presser, while the upper, or loose, end is passed partly around the boss of the flyer, through the hole in the side of the boss, out at the top, and overlapped and twisted with the roving projecting from the front roll. In piecing the roving by twisting in this manner long piecings should be avoided, since they cause the yarn to be too thick for some distance. Moreover, hard piecings should be avoided, since they do not draw well in the drawing rolls of the next process. After a piecing has been made, the frame is started slowly; very frequently it will be found that the end will remain slack for some time. In such cases it is sometimes the practice for the tender to retard the motion of the top front roll by pressing it with the finger or thumb, in order to cause the roving to become tight. This is not advisable, however, as it causes the roving for some distance to be thicker than usual; it is preferable to so adjust the bobbin before starting the frame that there will be as little slack as possible.

22. Doffing.—After a set of bobbins has been filled, it becomes necessary to remove the full bobbins and replace them with empty ones. This is known as **doffing**, and before the frame is stopped for this operation everything that is possible should be done to lessen the time to be devoted to this operation, since it causes a loss of production. Such points as having the empty boxes ready for the full bobbins must be looked out for before stopping the frame; also where it is possible, as in the case of the slubber or first intermediate, the empty bobbins should be laid on the carriage of the frame between the spindles, so that they will be ready to be placed on the spindles. The operation

is then as follows: After the frame has stopped, the cone belt is slackened by raising the bottom cone, so as to reduce the speed of the bobbin—when the frame is started again—to the same speed as the flyer and thus prevent any more roving from being wound on the bobbin; the frame is then run for an instant in order to cause a few coils of roving to form at the top of the flyer. The front row of flyers is then taken off and laid on the top of the top clearer covers, care being taken not to break the ends of the roving. The full bobbins are then removed from the front row of spindles and each replaced by two empty bobbins, the bottom one being intended to remain on the front spindles and the other to be subsequently placed on the back spindles. After doffing the front row of spindles, the tender doffs the back row of spindles by lifting the flyer, and replacing the full bobbin with the extra empty bobbin previously placed on the front row of spindles. The flyers for the front row of spindles are then placed in position. The end of roving is now laid on each bobbin and wound around in such a way that the outside coils will bind the inner ones, the coils of roving previously formed at the top of the flyer giving sufficient length to wind around the bobbins to make a new start. The cone belt is wound back to the other end of the cones by means of the rack and tightened by lowering the bottom cone, when the frame is ready to start.

23. Breaking Out.—In some cases, where a very radical change is made in the number of the yarn to be spun from the roving, it becomes necessary to make a considerable change in the hank of the roving being produced by the different frames. When any considerable change is made in fly frames, it is generally the custom to run the bobbins that are in the creel until half of them are almost empty and then remove all the bobbins from the creel, working them up in other frames. The creels are refilled with new bobbins of the correct hank, care being taken that half of them are half bobbins and that the other half are full bobbins, and the ends from these new bobbins pieced up to the ends of the

old roving projecting from the back roll. These piecings should be run through to the front and on to a set of empty bobbins, after which the short lengths should be removed from the bobbins so as to avoid any piecings or incorrect roving going forwards to the next process. This entire operation is technically known as **breaking out** and is an expensive process, since it is one that reduces production very largely; in many mills it is customary when making only a small change, say from 4-hank to 5-hank or from 10-hank to 12-hank, to do so by merely changing the necessary gears, thus avoiding this process.

24. Oiling.—In order to keep the machines in good condition, **oiling** should be carefully attended to; in large mills, there is usually some person who makes the oiling of machines his sole occupation. In small mills, it should be in charge of one of the section hands and not left to the tender. The rolls or gearing revolving at about the same speed as the front roll should be oiled every day; the bearings of the top and bottom cones, the jack-shaft, the horse head, certain parts of the compound, and all bearings around the compound, about twice a day. About once a month, the compound should be opened up—that is, slipped apart—and oiled and cleaned. When high speeds are employed, tallow should be used on the internal gears of the compound. The amount of oiling required by the spindle footsteps depends on their construction, but should be done at least once a month, while the upper bearings, or bolsters, should be oiled about once a day. All revolving parts not mentioned should be oiled at least once a week.

25. Care of Rolls.—The bottom drawing rolls on fly frames should be scoured at least once in 6 months.

The replacement of old top rolls with new ones is an important matter, and it is usual to allow so many rolls a week per frame or per hundred spindles in the room. This is something for which no definite rule can be given, as the condition of the frames, the care of the rolls, the stock being run, and the hank of the roving all make a difference as to the number of

rolls that should be allowed. Generally speaking, coarse roving requires more rolls than fine roving, and old frames more rolls than new frames. In one mill on medium numbers, it is customary to allow three new rolls weekly to each slubber and each intermediate frame, and four new rolls weekly to each roving frame. In this connection, it should be understood that the number of spindles in a roving frame is about double that in a slubber.

When solid top rolls are used, the rolls that are taken out of the front row should be moved to the second row and the rolls from the second row moved to the back row, the rolls in the back row being taken out to be recovered. In case the front rolls are shell rolls, which is usual with fly frames constructed at the present time, new shells replace the old ones that are taken out to be recovered, while new rolls are placed in the second row and the rolls taken out of the second row placed in the back row, the rolls in the back row being taken out to be recovered. Owing to the fact that the front rolls revolve at a much greater speed than the back rolls and that the larger part of the drafting is accomplished between the two front pairs of rolls, it is possible to run poorer rolls on the back row without injuring the stock.

26. In order to obtain the best results on fly frames, it is absolutely necessary that all parts should be kept as clean as possible. The creels should be brushed out twice every day and flyers should be wiped at every doff when running medium counts; when running fine roving, this should be done even more frequently. Twice a week the head-end covers should be taken off and the gearing cleaned. About once a month, the covers should be taken off the spindle and bobbin gears and all the waste picked off the gears and shafts. The head of the flyer should be kept clean and also the slot in the top of the spindle, so that the pin will fit accurately in it. Particular care should be taken to keep the rolls, roll beams, and clearers clean. If the steel rolls are allowed to become dirty or lapped with cotton they will produce bad work, frequently resulting in lumpy and

uneven roving and causing the ends to break at the succeeding processes. In general, it may be said that the floors of the room should be kept clean. Waste should be put in its proper place and not allowed to drop on the floor. Boxes and baskets should be provided for the empty and full bobbins, and should always be kept in their proper places.

COMMON DEFECTS

27. The following are some of the defects frequently met with in fly frames, together with their remedies:

1. *Breaking of ends* between the front roll and the bobbins sometimes results from the following causes: twist gear, draft, or other roll gears slipping or breaking; top-cone gear slipping; cones becoming loose; cone belt breaking; rolls breaking at the joints; spindle- or bobbin-shaft couplings becoming loose; driving gears at the head of the bobbin or spindle shafts breaking or becoming loose; bobbin, bobbin-shaft, spindle, or spindle-shaft gears breaking or becoming loose; any obstruction preventing the proper traverse of the carriage.

2. *Slack ends* on American-built frames are sometimes caused by the tension gear being too large. In trying the tension of the roving it is customary to place the forefinger under the roving as it is being delivered from the front roll to the flyer and draw it up slightly until it is tight, judging the tension in this way. A better way is to get the eye on a level with the flyer and by glancing from the boss of the flyer to the front roll note the slackness in the roving. If there is not quite enough tension, the roving will run all right for a short length of time, but will then partially curl around the boss of the flyer, afterwards running along all right again. If a greater amount of tension is needed, the roving will wind round the boss of the flyer and break, although this is sometimes caused by the end breaking in the flyer. The tension of the roving is an important matter and should be carefully watched at all times, as there are several points that will affect it. For example, the cone belt may slip because it is

too slack or too heavily loaded; because the spindle bolsters are not properly oiled or are allowed to become clogged with dirt or cotton; because the bolsters are not properly adjusted or are not plumb, thus causing the bolster rail to run hard; or because the racks bind in the slides. As the lifting motion is driven through the cones, any drag on the bobbin rail is liable to cause the belt to slip and thus affect the tension.

3. *Incorrect Traverse.*—Sometimes the clutch gear between the twin gears becomes loose or has been set wrong, in which case there will either be no traverse given to the carriage or the traverse will be imperfect and the roving that is being delivered will be wound on the bobbin in one place, thus producing a ridge on the bobbin.

4. *Running over and under* of the roving on the bobbins is a serious defect, and every means should be adopted to prevent it. The following are some of the precautions that should be taken: All gears from builder to carriage must be in their places and firm on their individual studs and shafts. The spring at the bottom of the tumbling shaft must exert its proper tension. If it has not enough tension to pull the tumbling shaft around so that the teeth on the gear fixed at its upper end come in contact with the top-cone gear, it will cause either running over or under of the roving. The clutch gear situated between the twin gears must be tight and properly adjusted; the twin gears must also be properly adjusted and tight on their shaft. Running over or under is also frequently caused by the carriage not being perfectly level during its entire traverse. Individual bobbins are spoiled by the bobbins not being correctly fitted or not resting properly in their places. At times the pin breaking in the boss of the flyer will cause the roving to run under or over either because of the flyer settling down or because of centrifugal force causing the flyer to rise.

5. *Imperfect Flyers.*—It is very important that flyers should be smooth inside and outside at all points where cotton passes and should fit well on the tops of the spindles so as to obviate the necessity of hammering them down and thus making them rough at the top. When the presser on the flyer leg works

stiffly and consequently does not exert enough centripetal pressure on the bobbin, it causes soft bobbins and a weak roving that will often break when being unwound at the next process, thus causing annoyance and bad spinning at the final operation.

6. When the small bevel gear that drives the bobbins is not properly meshed with the bobbin gear, or when either gear is worn, it will cause the bobbin to jump and will break the end or stretch the roving. This may be obviated by having a systematic inspection of these gears and requiring that such cases be reported at once. Sometimes the same effect is produced when a bobbin shaft is crooked or strained, or when a section of the shaft works loose and slides slightly in its bearings. In this case it will affect several bobbins. The same is also true of the spindles, in which case the spindles will jump up and down, instead of the bobbins.

Sometimes the help after neglecting to piece up an end promptly, find that the bobbin is too small in diameter to take up all the roving that has been delivered by the rolls. In order to remedy this and not to be blamed for running an empty spindle, they will pack cotton under the weight hook to cause extra friction on the top roll and reduce its speed, or they will hold the top roll with one thumb to attain the same object. This causes two or four ends to be heavier than the others that are being made, to the extent of as much as 30 or 40 per cent. for a short distance, which obviously causes undue variation in the numbers of the yarn at the spinning room.

SIZING

28. It is customary to test the numbers of roving, or in other words to *size roving*, by reeling off a standard length from bobbins. The length usually taken in case of slubber and first intermediate roving is 12 yards; for second intermediate or fine roving, 24 yards. The bobbin is placed on a skewer in a frame usually adjustable for large or small bobbins, the end passed through a guide eye to the reel, which is

18 or 36 inches in circumference, and the desired length measured off. When this is done the end is broken, the roving weighed on a small pair of scales known as **roving scales,** and the hank of the roving calculated.

In some cases the roving is sized at the drawing frame, while in other cases the slubber is taken as the starting point; the roving delivered is weighed two or sometimes three times a day, two bobbins being taken from a doff. Twelve yards are reeled off each bobbin and weighed and the average taken. If the average varies considerably either way from the correct weight of that number of yards of the hank being made, the draft gear is changed. These averages are kept in a special book for this purpose, which can be referred to at subsequent dates. The bobbins from frames finer than the slubber are weighed generally once a day, two or even more bobbins being taken from each frame. Where there is a difference from the standard of $2\frac{1}{2}$ grains in hanks from 1.5 to 4, or a difference of 2 grains in hanks from 4 to 12, a change is made. After the roving has been weighed, in mills where a high standard is maintained, a certain number of bobbins, usually 16, of the different hanks of roving is taken to the spinning room and the yarn made from them sized and tested for strength, a record being made and a copy sent to the overseer of carding. This is the method adopted in fine-yarn mills; in other mills, the bobbins are not sized so often.

Care should be taken in selecting the bobbins to be sized that they contain no single or double. Where more than one frame is on a certain hank or grade of work, the different frames should be sized in their turn. If the gear on one frame is changed on a certain hank or grade of work, all the frames running under similar conditions should be changed. This not only applies to roving frames, but to all machines in a mill where changes must be made.

There are various systems of keeping numbers and various limits set for the number of grains that roving should be allowed to vary from either side of the standard before changing the draft gear. The one explained may be taken as a basis.

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